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METHODS FOR THE PROCESSING OF AUV DIGITAL IMAGERY FROM SOUTH EASTERN TASMANIA – JUNE 2011

LISA MEYER, NICOLE HILL, PETER WALSH & NEVILLE BARRETT

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Methods for the processing and scoring of AUV digital imagery from South Eastern Tasmania

Lisa Meyer, Nicole Hill, Peter Walsh & Neville Barrett

Executive Summary

This report details work undertaken as part of the Commonwealth Environmental Research Facility (CERF) Marine Biodiversity Hub's Surrogacy Program at the University of Tasmania. One aim of the CERF Marine Biodiversity Hub is to develop tools and methods to quantitatively describe and predict Australia's marine biodiversity. Temperate rocky reefs in particular, are as yet poorly understood with respect to their cross-shelf distribution, overall extent, physical complexity, and associated biological diversity. To address this, surveys were undertaken in 2008/9 in collaboration with Geoscience Australia (GA) and the Integrated Marine Observing System (IMOS) Autonomous Underwater Vehicle (AUV) Facility to map reefs in south-east Tasmania using multi-beam sonar and collect precisely geo-referenced biological data.

Some specific objectives of the surveys were to i) enable biological assemblages associated with rocky reef systems in temperate waters (20 to 95m) to be identified and quantitatively described and ii) test the utility of multi-beam products as surrogates of biodiversity.

This document outlines the methods used to process and score the biological data contained in the digital images collected by the AUV Sirius from the south-east Tasmanian surveys and the associated data management for the CERF Program. Image processing was undertaken with the digital imaging software Coral Point Count with Excel extensions (Kohler & Gill 2006) with biota being scored to the lowest identifiable taxonomic resolution, as well as identifying other important abiotic factors such as rugosity, substrate type and form/slope. The database that was developed to store data obtained from the scoring of AUV images is also described.

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1. Background

As part of the CERF Marine Biodiversity Hub's Surrogates Program, two surveys mapping rocky reefs in southeast Tasmania were undertaken in 2008/9 aboard the R.V. Challenger. The objectives of these surveys were to obtain high resolution multi-beam data and precisely geo-located biological data to enable the mapping of reef structures, quantitative descriptions of deeper reef communities and to investigate surrogacy relationships and their predictive capacity between physical characteristics of the seafloor and benthic biota and habitats. A detailed description of the survey methods, the geology and physical characteristics of the region and a preliminary biological characterisation using towed video data can be found in Nichols *et al* (2009). This report details the methods used to process and extract fine-scale biological data from still images captured by the Autonomous Underwater Vehicle (AUV) *Sirius.*

The AUV *Sirius* was developed and is operated by the University of Sydney's Australian Centre for Field Robotics and managed through the Integrated Marine Observing System (IMOS) AUV Facility. The AUV is equipped with a suite of sophisticated cameras, sensors, and sonar equipment. An Ultra Short Baseline sonar system (USBL) attached to the AUV allows the stereo camera system to take precisely geo-referenced photographs of the seafloor. Still images are taken every second with approximately >40% overlap. A mosaic of images is created using SLAM image-recognition software and provide a continuous interwoven 2-3 m wide mesh of the seafloor along the path of the mission and is a useful tool for visualisation. In addition, a range of sensors on the AUV measure environmental parameters such as conductivity, temperature, dissolved oxygen and chlorophyll-a. The AUV is also fitted with a multi-beam sonar unit that scans the seafloor returning depth and textural information that can be used to quantify very fine-scale habitat complexity (~ 50 cm) along a narrow swath (2-3 m). Further information about the AUV *Sirius* can be found at http://imos.org.au/auv.html and in Nichol *et al* 2009.

The AUV *Sirius* undertook seafloor survey deployments along the Tasman Peninsula, at Port Arthur and in the Huon Channel between October 5th and 16th, 2008. The region along Freycinet Peninsula and the Huon Marine Protected Area was surveyed between 9th and 16th June 2009. A total of 28 transects were attempted (Fig. 1), but some were aborted due to bad weather, malfunctions or poor visibility (Port Arthur and Huon Channel). Twenty-two transects contained good-quality images that were subsequently processed. Each transect consisted of a pre-programmed, multiple-leg track with ideally two to three tracklines traversing down the slope of the substrate and several tracks perpendicular to these tracks (generally following a depth contour, see Fig. 2). This design was chosen for a number of reasons; i) multiple tracklines were surveyed along and across the slope to provide replication of imagery at each depth within each habitat feature for determination of natural variability at multiple scales (metre scale for variability between adjacent images, 100 m scale for variation between adjacent tracks) and ii) the crossover pattern enabled the AUV to cross-reference and correct it's actual position along the trackline via image recognition at crossover points. AUV transects were generally 1 km in length (along each trackline), and typically traversed a coastal reef from a minimum safe depth of 15 m (to avoid adverse swell related motion in shallower water and entanglement in giant-kelp) to beyond the reef/sediment margin.

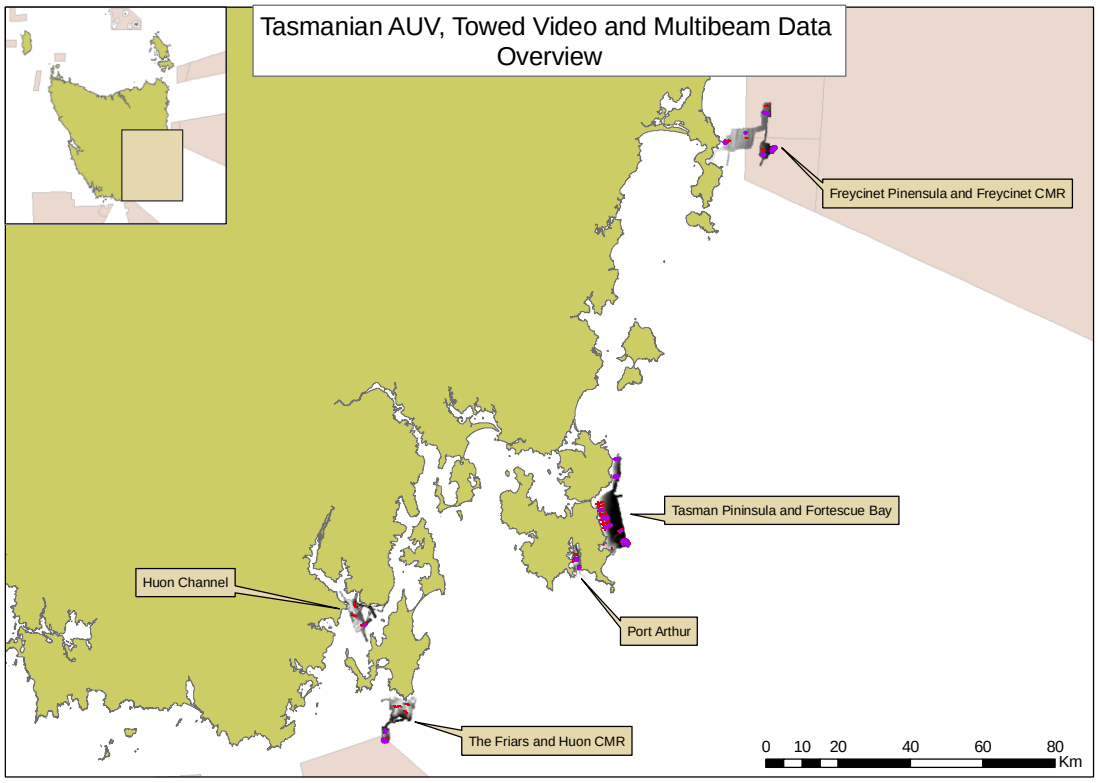

Fig. 1. Overview of areas surveyed with multi-beam, towed video and AUV.

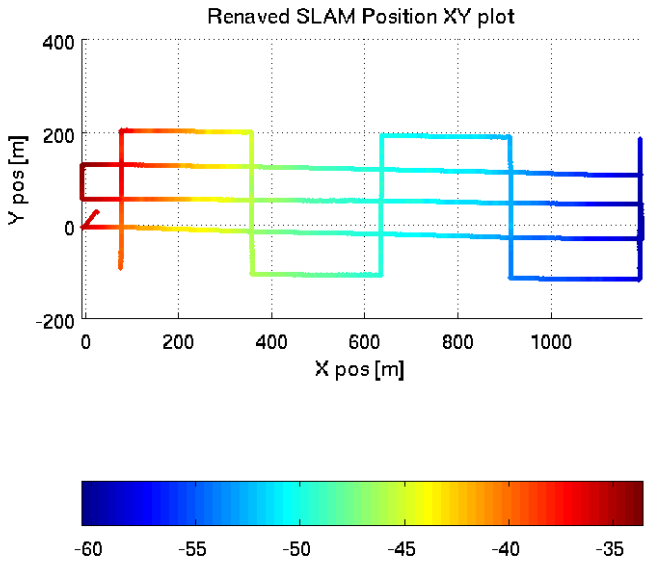

Fig. 2. Example of the AUV tracklines from the high yellow bluff_19 transect on the Tasman Peninsula.

From the 2008/09 data, a total of 1904 images were processed from 22 transects; eight transects from the Tasman Peninsula, 11 from Fortescue Bay and three from the Huon Marine Protected Area (Table 1). Reefs ranged in depth from 20 to 95 m.

There were 116,049 overlapping stereo image pairs taken during the entire survey. Transects were subsampled initially, so within each transect, every 100th image was sampled for scoring. Images captured an approximate 2.1m^2 area (1.6 x 1.3m) of the seafloor and associated biota, and scored images were approximately 40m apart along the transect path. Preliminary investigations revealed that sampling every 100th image provided representative coverage of images across the substrates and depths in the study regions. Images were scored for rugosity, substrate type, form/slope and overall sponge size (refer to Appendix A for categories), as well as identifying flora and fauna under 50 random points. Benthos was identified to the lowest taxonomic grouping possible with the survey focusing on sessile invertebrates.

Table 1. Names of AUV survey transects, the number of images per transect and the number of images scored

Transect name	Number of images in transect / scored
Tasman Peninsula	
Waterfall 05	11933 / 120
Waterfall 06	7144 / 70
OHara 07	11280 / 112
OHara 20	6564 / 65
Patch Reef north 08	6944 / 69
Blowhole 15	10563 / 105
Sisters 16	15521 / 155
High Yellow 19	15162 / 151
Fortescue Bay	
Hippo 09	6145 / 61
Hippo 13	6870 / 67
Little Hippo 11	6727 / 67
Little Hippo 12	6787 / 67
Chevron Rocks 10	6406 / 64
Chevron Rocks 14	7737 / 75
Freycinet	
Freycinet MPA 03	10563 / 88
Freycinet MPA 04	15521 / 101
Freycinet MPA 05	15162 / 175
Freycinet MPA 06	4460 / 44
Nuggets Inshore 13	7911 / 79
Huon MPA	
Huon MPA 15	8580 / 85
Huon MPA 16	9956 / 99
Huon MPA 17	7931 / 79

The processing and scoring of images involved several steps and this document details the procedures that were followed. It is intended as an in-house manual for future image scoring related to the current CERF project. The main steps involved in processing images are illustrated in a flow diagram (Figure 3) and these are detailed in the following sections. All the images were collected as geotiff files (geographically referenced tiff files), which were converted to jpeg files before analysis using the program XnView. Only the left hand images from the stereo image pairs were used.

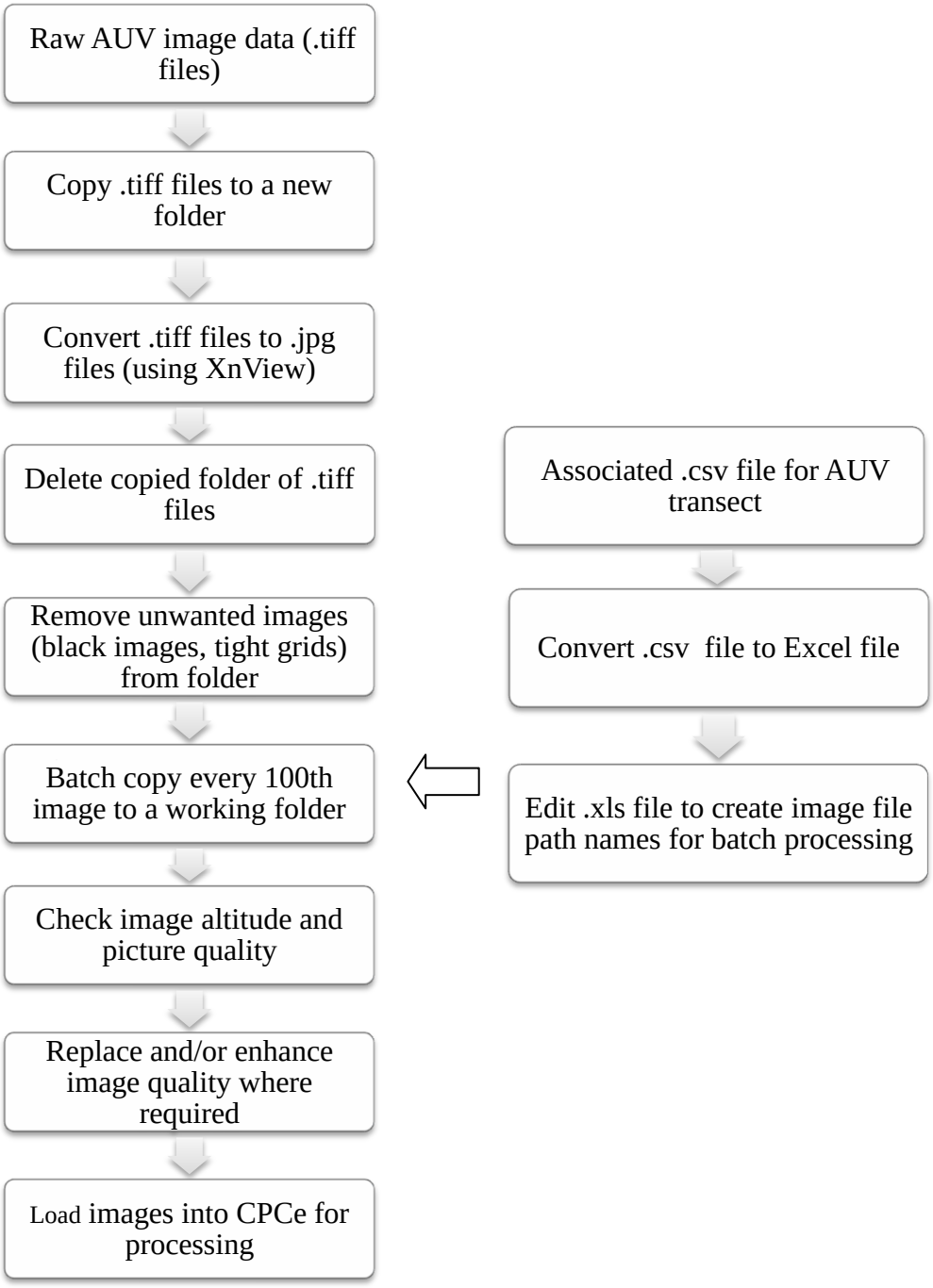

Fig. 3. Flow diagrams of the main steps in image processing

2. Methods

2.1 Data Management

2.1.1 Original image files

All of the AUV image files are located within folders for each transect on the R server.

Data collected in 2008 are stored in:
R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\Tasmania200810

Data collected in 2009 are stored in:
R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\Tasmania2009_2cruises

Data collected in 2010 are stored in:
R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\Tasmania_2010_cruise\RELEASE_DATA\Tasmania201006

Within this directory each folder corresponds to the individual transect name, for example, for the Waterfall Bay transect:
R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\Tasmania200810\r20081006_231255_waterfall_05_transect

Within each transect's folder there are four subfolders that contain related data and information from the AUV survey. Refer to Table 2 for descriptions.

Table 2. File names and directory locations for AUV survey data (using the Waterfall 05 transect as an example)

Folder Name	Folder Description
hydro20081027	Water quality data, including water temperature, turbidity and Chlorophyll a.
i20081006_231255_gtif	The original geotiff images from the AUV.
mb	Multibeam data collected by the AUV.
mesh	3D images of the entire transect, meshed together and viewable using the OSG Sight program (located in R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\osgsight).
Waterfall_05_Transect_jpg	Converted JPEG images of the original .gtiff AUV files. Files were converted by using XnView. Files that are black (images taken when the AUV ascends/descends) have been deleted from the folder.
Waterfall_05_filecopy100	The batch copied JPEG images from the Waterfall_05_Transect_jpg (contains every 100th image).
20081006_231255_waterfall_05_transect_latlong.csv	Information on the latitude, longitude, camera altitude and water depth of images in the transect.

2.2 Preparation for scoring images

There are several data processing steps that must be completed prior to processing the images in CPCe. As the images are scored in transect batches, the entire transect's images must be checked for clarity and then improved where required.

The following outlines the procedures undertaken for processing images from an AUV transect:

1. Make a copy of the folder containing the original .tif images.
2. Convert the .tif files to .jpg using XnView. Name the folder "*TransectNameNumber*_jpg". When this is completed delete the copied folder of the .tif files to save memory space on the server.
3. Copy the folder with the .jpg images and delete any images that are not required for scoring (e.g. black images, tight grids).
4. Batch copy every 100th image to a working folder (Section 2.2.2).
5. Check the visual quality of all these images and enhance images (e.g. alter brightness/contrast) where necessary with XnView, Picassa or other digital image software.
6. Check the altitude of all of these images and replace images where necessary. Altitude and depth information can be found in the associated .csv file. Images with an altitude $\geq$ 3.5 to 4m were generally not suitable for scoring, but this altitude reading may only be from a small section of the image.
7. Images are now ready to be loaded into CPCe for processing (Section 2.3.3).

2.2.1 CSV file information

A .csv file was provided by the AUV Sirius that contains positional information about the images taken within an AUV transect (longitude, latitude, heading, water depth, camera altitude, etc).

A copy of the .csv file was converted to an Excel spreadsheet to filter the data relevant to the image processing:

- selecting every 100th image (Excel code: =MOD(ROW(A1),100))
- left image name
- Depth and Altitude added to determine total water depth

This was necessary as the AUV image scoring database was under construction at this time.

2.2.2 Batch copying of images for scoring

For the batch processing of any files within the 'Marine Environment' folder the following process must be followed.

1. The .bat program has a character limit of 255 characters. The normal directory location of the image files has a path name that is 207 characters long so the folder must be moved to a higher directory to shorten this path name.

2. Any path name with spaces must be enclosed in quotation marks. The target folder (where the files are to be transferred to) must consist of the entire file path name and be enclosed in quotation marks because there is a space in the file path name.

3. A text file is required that consists of a list of the image files that are to be copied (i.e. every 100th image). Again, this text file must have the entire file path name enclosed in quotes.

4. The .txt file must reside in the same location as the .bat file because this is where the .bat program looks for it. Within the .bat program, the .txt file name must be enclosed in brackets (only the file name and not the entire path name) as below.

An example of the program syntax for the Nuggets25 transect reads as follows:

```
for /F "delims=," %%a in (Nuggets25.txt) do copy %%a
"R:\TAFI\TAFI_MRL_Sections\Marine
Environment\CERF\AUV\Nuggets25_filecopy100_241110"
```

Double click file name to run the program.

Right click to edit - then click Run to open the program to edit it.

Originally when working on the 2008/09 AUV data the image files were stored in the R:\TAFI\Data\CERF\AUV directory so the program codes and associated files reflect this. All the files have now been moved to the Marine Environment folder, so the .bat programs would have to be altered to work.

Location of the original "filecopy test.bat" program:
R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\Image_scoring\Batch\Filecopytest.bat

Transect specific "filecopy test.bat" programs reside in the 'Batch' folder (or some of them reside in the transect's folder):
R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\Image_scoring\Batch\ Ohara07_Filecopy_091209.bat

Table 3. Image management file names and directory locations

Directory	File name	Folder/File description
R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\Image_scoring\Batch	Batch copying of images for scoring.docx	Description of process for copying every nth image file to a specified directory.
R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\Image_scoring\Batch	Filecopytest.bat	Example of program to use for file copying from one location to another. Edit as appropriate.

2.3 Image scoring

2.3.1 Instructions for using CPCe

Coral Point Count with Excel extensions (CPCe) Version 3.6, is the freeware program that has been used to score the AUV images.

CPCe is a tool designed by the National Coral Reef Institute (NCRI) for researchers in the fields of coral reef management, assessment and monitoring. The operation of CPCe is easy and is well described in Kohler and Gill (2006). There are two main files that are required by CPCe in the image scoring process, namely the Code File and the Colour File (Table 4; Section 2.3.2).

The basic operations of CPCe consist of a digital image, defining a frame border, overlaying random points, identifying the 'species' under each point and saving the data to file. Initially a .cpc file is generated that contains all the point scoring data and a reference to the image being scored. After all the images in a transect are processed the .cpc data can be converted to Excel spreadsheets for uploading into a database and for statistical analysis.

Table 4. CPCe code file names and directory locations

File name	Directory	Folder/File description
cpce36_setup_full.exe	R:\TAFI\TAFI_MRL_Sections\ Marine Environment\CERF\ AUV\Image_scoring\CPCe36	Coral Point Count with Excel extensions (CPCe) program application file. To get a new copy of the program… Download instructions: URL: http://www.nova.edu/ocean/cpce/downloads The username is cpceuser, and password is cpce127. Additional information can be found at: http://www.nova.edu/ocean/cpce/
CERF_AUV_codes_171209.txt	R:\TAFI\TAFI_MRL_Sections\ Marine Environment\CERF\ AUV\Image_scoring\CPCe36	CPCe code file for scoring images.
CERF_AUV_codes_110110.txt	R:\TAFI\TAFI_MRL_Sections\ Marine Environment\CERF\ AUV\Image_scoring\CPCe36	CPCe code file for scoring images in the Freycinet MPA region, including the NuggetsInshore13 transect.
CERF_AUV_codes_10022010_gravel.txt	R:\TAFI\TAFI_MRL_Sections\ Marine Environment\CERF\ AUV\Image_scoring\CPCe36	CPCe code file for scoring images with gravel (there have only been a few images like this in the HighYellow19, Huon15 and Huon16 transects).
Combined_code_file_list_16032010.txt	R:\TAFI\TAFI_MRL_Sections\ Marine Environment\CERF\ AUV\Image_scoring\CPCe36	Combination of all code files created for importing the species list to the CERF database. DO NOT USE FOR SCORING IMAGES
R:\TAFI\TAFI_MRL_Sections\Marine Environment\ CERF\AUV\ Image_scoring\CPCe36	CERF_colour_241109.clr	Colour file used in CPCe to colour-code the code category boxes.

2.3.2 Image and code file specification

CPCe requires two files to be loaded before scoring the photographs:

1. **Code file**, which is an ASCII text file that has all the individual species codes/categories used for scoring. The code file can be changed to whatever categories are required, but the formatting must be the same as in the original code file that is provided with CPCe. The code file can be found in the following location (refer to Table 4):

R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\
Image_scoring\CPCe36\CERF_AUV_codes_*most recent date & version number*.txt

2. **Colour file**, which applies colour to the different categories specified in the Code file. This file is not a requirement to operate CPCe, but makes scoring easier as category codes can be found faster. The colour file can be found in the following location:
R:\TAFI\TAFI_MRL_Sections\MarineEnvironment\CERF\AUV\
Image_scoring\CPCe36\CERF_colour_241109_5.txt

Once the CPCe program is opened the **Code file** must be specified:

- Options →Specify Code file
- Set the directory location of the code file and click 'Open'.

This will set the code file until it is changed, so it is important to set this before scoring images if a different code file is required.

In CPCe the **Colour file** can be selected and loaded by going to:

- Options→Colour code codename category boxes
- Click 'Import colour file' (select "CERF_colour_241109_5.txt", unless you want to change the colour of the categories yourself).
- Click 'Apply colours'
- Click 'Close'.

2.3.3 Opening image files to process

Choose to open one image file or many:

- File → Open → Raw image file

OR

- File → Open → Multiple images/file processing → Process multiple images

Set the directory window:

- 'Auto-advance fileset information window' opens
- Set the computer drive to r: and double-click on each sub-folder to navigate to the files required for processing (Fig. 4).

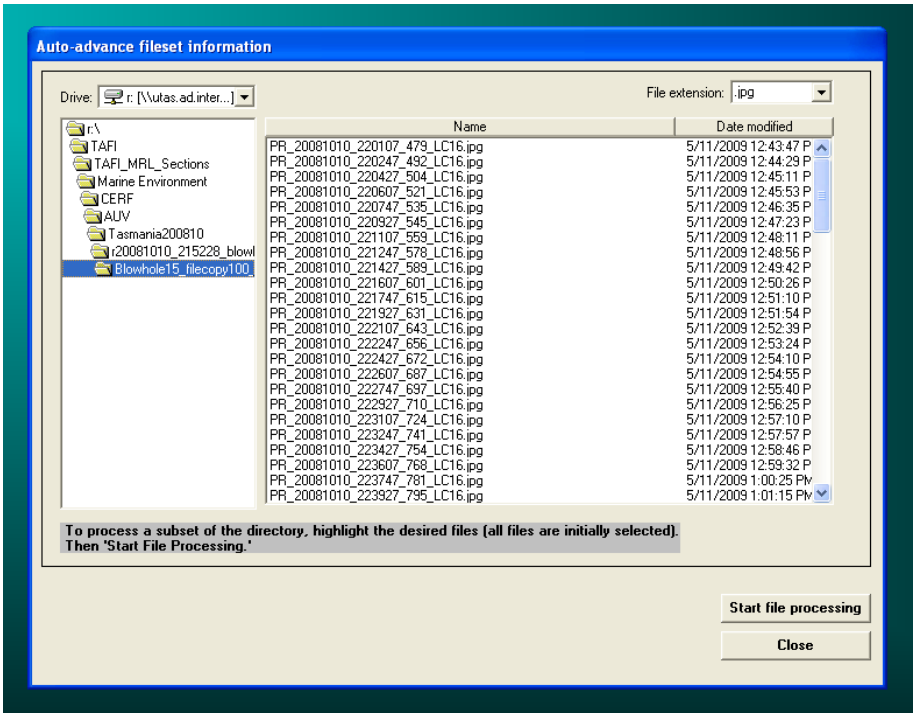

Fig. 4. Navigation to the file directory in CPCe

2.3.4 Border designation

A border around the image was specified by setting the border offset in pixels in the *x*- and *y*-direction, which was set at 5 for each direction.

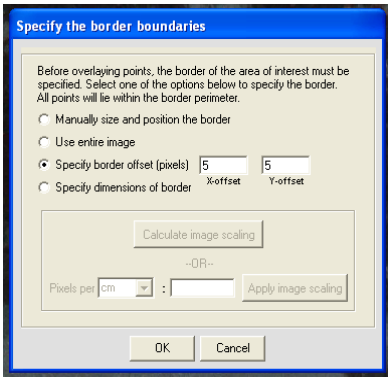

Fig. 5. Border boundary specification options

2.3.5 Random point specification

The random points that are overlaid on an image were applied using the simple random method, where every pixel within the marked border boundary has an equal likelihood of being picked for the position of the random points (Kohler and Gill, 2006). Fifty-five points were applied and the first 5 points were used to describe information on the scorer identification code, rugosity of terrain visible in the image, substrate type, form/slope of terrain and sponge size (Fig. 6 & 7). Appendix A lists the different codes used for these categories.

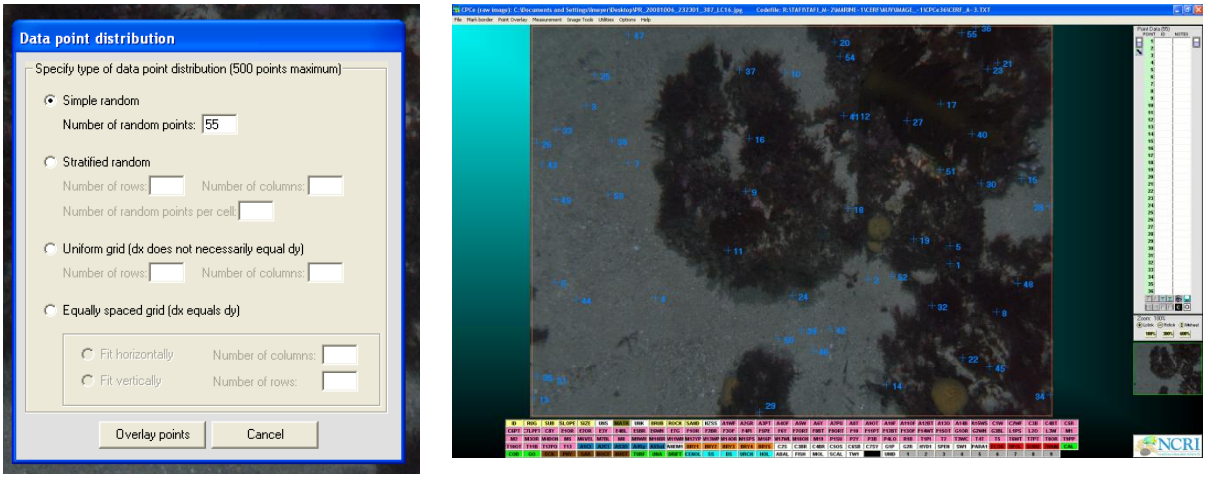

Fig. 6. Data point distribution types in CPCe (left) and with 55 random points applied to an image (right).

2.3.6 Scoring data points

The first step in scoring the image is to complete the data for the first 5 points. Put the cursor in the ID column at Point 1 and with the mouse click ID (top left of code buttons). The cursor then moves down automatically to position 2. Click RUG, then SUB, SLOPE and SIZE. Fill these in before scoring any other data points. You can move the cursor to the Notes column on the right with the mouse or the keyboard arrows.

Then data points can be scored sequentially or in blocks. For example, in Fig. 4, all the points on the sand were selected (while holding Ctrl) and then SAND was clicked on the code buttons (Fig. 7).

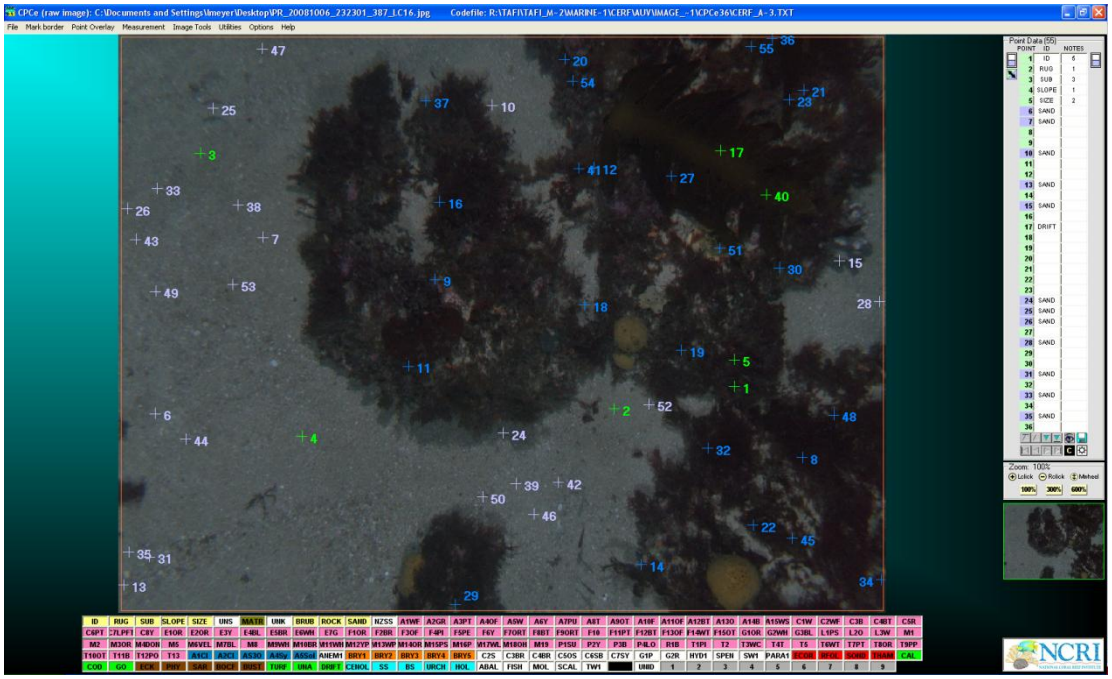

Fig. 7. CPCe with point scoring in progress.

2.3.7 Saving data - .cpc files

Data can be saved at any time during the analysis. If a .cpc file is created, the image and point data can be retrieved at a later stage for further analysis and/or modification (Kohler and Gill, 2006).

When processing multiple images, CPCe automatically saves a .cpc file once you move to the next image. However, it is important to save files regularly to avoid losing data if CPCe crashes/freezes.

Once all the data points have been assigned a code (always double-check this), then click the Save button. Navigate to the desired directory to save the file (Fig. 8). The directory location chosen will automatically be set for the next save, after the first time it is chosen, during an open session with CPCe.

The .cpc files are saved in the same directory location as the image files.

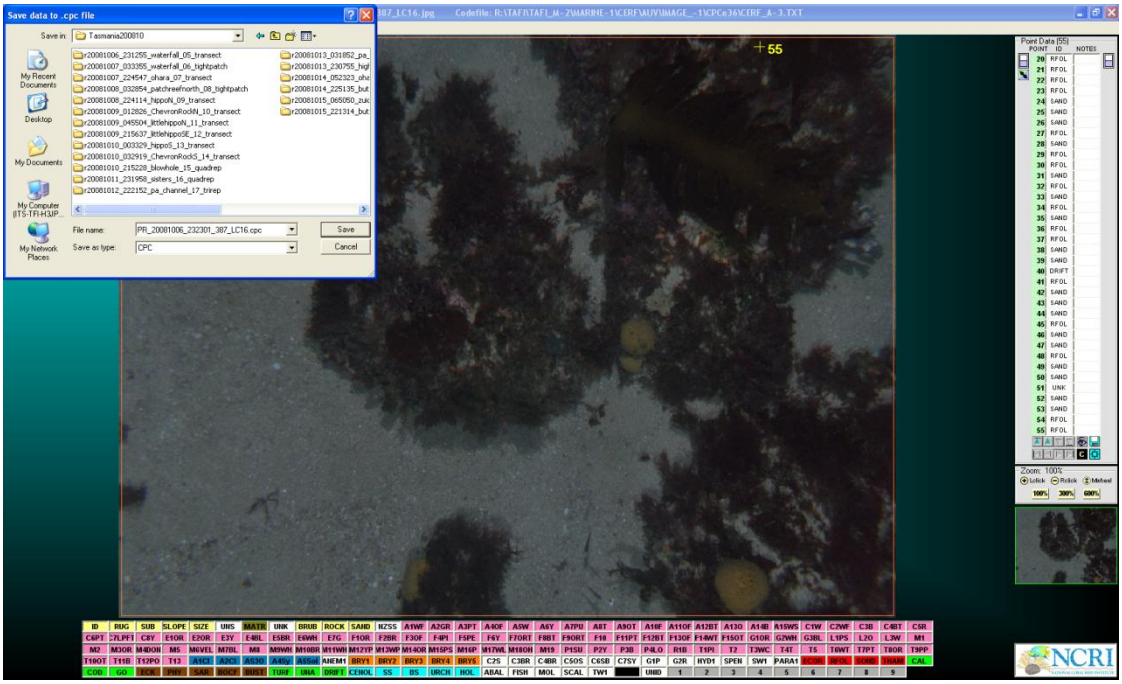

Fig. 8. Saving the .cpc file.

2.3.8 Creating data summaries in Excel

Once all of the images in a transect have been scored and each image has a .cpc file, an Excel workbook of data summaries can be created.

File → Save → Save .cpc file(s) to Excel
Navigate to the desired directory location.
Click 'Start file processing'.
Enter transect name.
Select .xls format (not .xlsx)
CPCe will run through the processing and display an error when finished (see below).
Click OK.

The resulting Excel workbook gets saved in the same location as the .cpc files.
Open by right-hand clicking on the last .cpc file in the list
Select Open with Excel.

There are two workbooks that are created (*Book1* and the other has the same name as the .cpc file that was opened with Excel). "Book1" is the summary of the .cpc files.

There have been a few glitches in this process, so if it does not work then keep trying a few times/restart program/reboot computer/try later.

Within the Book1 workbook, there are five Excel worksheets with various data summaries, but the only worksheet of interest to this project is the one named 'imgsummary' that contains the raw data from the image scoring. To successfully upload the worksheet to the TAFI Marine Biodiversity Database, two changes must be made to the worksheet:

- the worksheet name is originally "*transectName*_imgsummary", but this must be changed to "imgsummary";
- the first Row of the worksheet must be deleted.

All of the data summaries are stored in the following directory location:
R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\
Image_scoring\LISA\CPCeDataSummaries

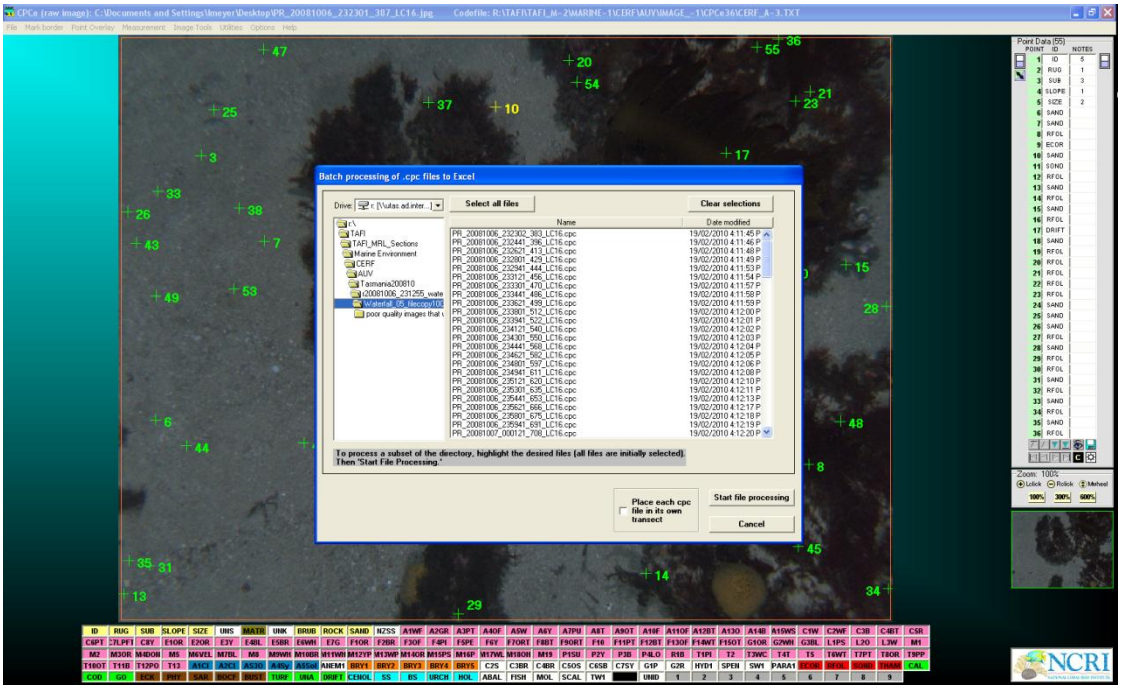

Fig. 9. Saving the .cpc files to an Excel workbook.

Fig. 10. Run time error in CPCe after creating .xls summaries from .cpc files.

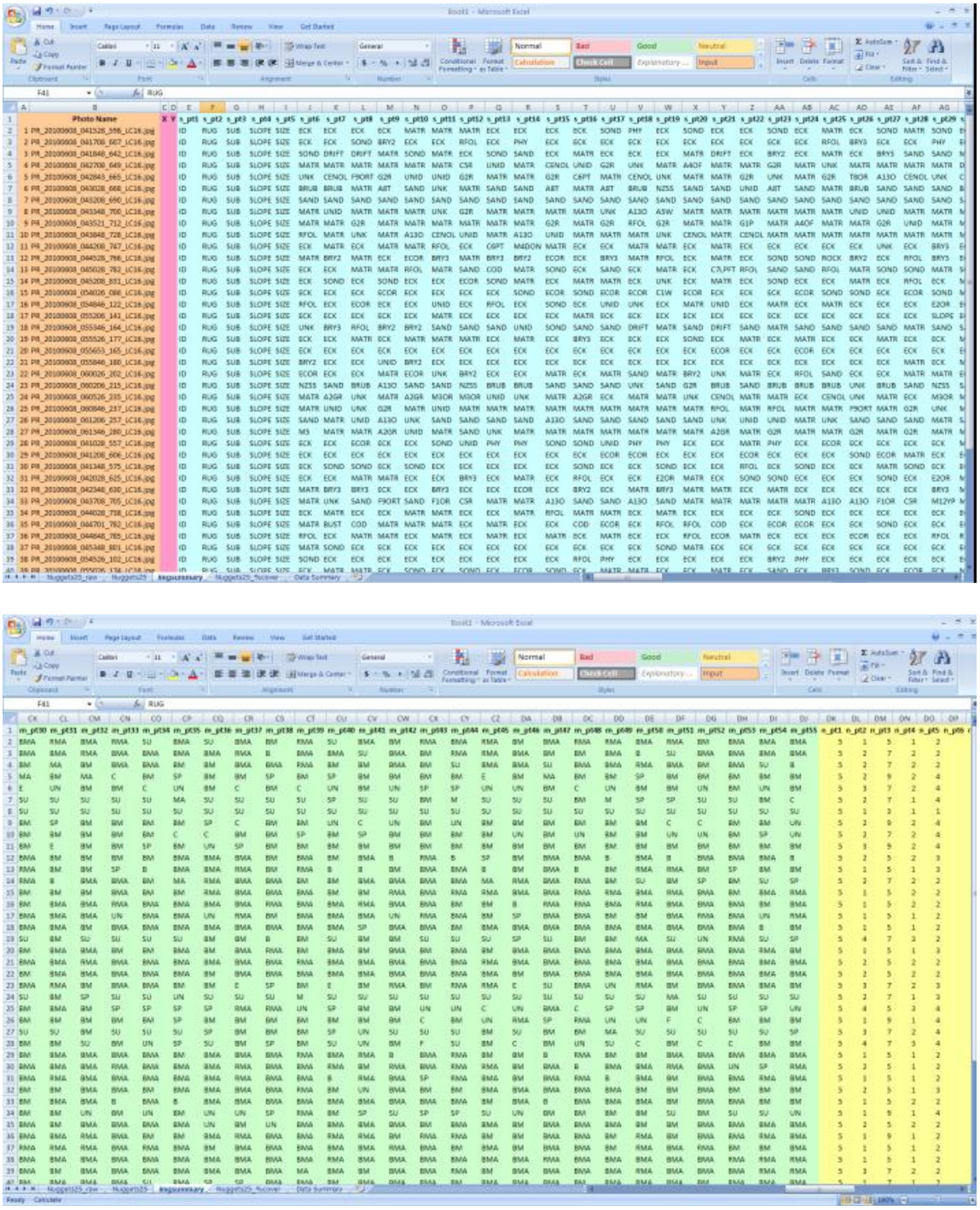

Fig. 11. An example of the Excel data summary of the .cpc files created by CPCe.

2.4 Species Identification

Within each image, benthos was scored to the lowest taxonomic level possible (Edgar 2008; Gowlett-Holmes, 2008), concentrating on sessile invertebrates and algae (Fuhrer 1988; Huisman, 2000). For invertebrates this was generally morphotype and for some algae this was species or genus and is referred to in this document as 'species'. Species were also assigned a range of other classifications either in the scoring phase, to assist with identification, or subsequently within the database. These included a taxonomic classification for all species, habitat groups for algae and functional groups for cnidarians (see Section 3: The AUV Database, for further details). Table 7 lists the taxonomic groupings and associated codes used in the Marine Biodiversity Database.

Sponges were a dominant group and were classified in the scoring phase according to their predominant morphology, which is outlined in Table 5. Morphological categories were adapted from Bell and Barnes (2001) and Boury-Esnault and Rützler (1997). Sponges were then numbered and classified according to some other easily observed feature, such as colour to uniquely identify and simplify the codes used in CPCe. For example, a sponge scoring code of C5R, means the organism is a cup sponge, it's the 5^{th} one that's been categorised and it is red in colour.

Organisms that were unidentifiable, but clearly biological matter were scored as Unknown Biology (UNK). Any points that were completely unscorable (dark/blurry areas) were scored as Unscorable (UNS). There was also a Biolgical Matrix category for areas that were a mixture of hydroids, brozoans, ascidians, algae and small sponge pieces etc.

Table 5. Sponge morphology category descriptions

Category	Definition
Arborescent	high profile, upright with branching structure
Cup	round, vessel-like shape, often stalked attachment to the substrate
Encrusting	thin, sheet-like coating of the substrate
Fan	flat, upright, variable thickness, often stalked attachment to the substrate
Globular	ball-like shape, often irregular projections that anchor it to the substrate
Lumpy	variable size, lacking definable shape/form
Massive	large, compact structure without definable shape
Papillate	low profile with finger-like projections
Repent	low profile with branching structure
Tubular	singular or colonial, upright with cylindrical form, sometimes flanged, exhalent openings

2.5 Species catalogues

Four catalogues were produced to assist with the classification and identification of species scored during image analysis; Sponges, Macroalgae and Mobiles, Corals and Others, and Unidentified Species (Table 6). There are currently 259 'species' in the catalogue, but not all have been scored in the images as the catalogue was started before scoring began. The term 'species' is used loosely in this instance as biota was generally scored to a much higher taxonomic resolution. A table of the biota scored and the associated codes is listed in Appendix B. Generally biota had a unique scoring code, but a few biota scored in the Freycinet Peninsula transects have two codes; an UNID number and a normal unique code (Fig. 11). The species catalogues are available by contact of Neville Barrett (Neville.Barrett@utas.edu.au).

Figure 12 illustrates the layout and how information in the species catalogues is generally provided.

Code name Taxonomic Group/Sponge Morphology Group *Image* Image name	Another image example of the biota AUV transect name Notes/Comments

Fig. 12. An example of the layout of the image catalogue.

Figure 11 illustrates how an organism with two reference codes is displayed in the Unidentified Species Catalogue. In the Freycinet Peninsula code file (CERF_AUV_codes_110110.txt) the organism is identified using the code "A16BT" in CPCe. In all other code files the organism is identified using the code "UNID 10", which is recorded in the Additional Data form.

UNID 10 Arborescent

Arborescent 16 brown thick (A16BT – FREY ONLY)

Copy of PR_20090326_012815_879_LC16.tif

Fig. 11. An example of how biota with two reference codes is displayed in the Unidentified Species Catalogue.

Table 6. Species catalogue file names and directory locations

File/Folder name	Directory	Folder/File description
Unidentified Species Catalogue_16032010.docx	R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\ Image_scoring\Species catalogue	Latest version of the unidentified (i.e. the 'new') species scored in CPCe. These images have been incorporated into the three catalogues below up to UNID 104.
Sponge ID Catalogue_04022010.docx	R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\ Image_scoring\Species catalogue	Latest version of the sponge identification catalogue.
Macroalgae and Mobiles ID Catalogue_04022010.docx	R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV \Image_scoring\Species catalogue	Latest version of the algae and mobile species (molluscs, echinoderms, fish etc).
Corals and Others ID Catalogue_04022010.docx	R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\ Image_scoring\Species catalogue	Latest version of the corals, bryozoans, hydroids etc.
SPECIES_ID_PHOTOS	R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\ Image_scoring\LISA\ImageIDs\	Images that were used to make the original species catalogue.
New images	R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\ Image_scoring\LISA\ImageIDs\	Images that were used to make the unidentified species catalogue.
Substrate Images	R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\ Image_scoring\LISA\ImageIDs\	Images of some examples of substrate types in the images scored.

2.6 Instructions for adding new species data

The code file that CPCe uses has a list of the most commonly used species codes for the analysis. However, as new species were constantly discovered, an UNID code is assigned to the data point that is on the new organism and then the associated data is recorded into an Excel workbook, titled "AdditionalData_*TransectName*.xls". This data is later combined in the database when the summary data is uploaded (refer to Section 3.3).

There are two worksheets that must be recorded in the workbook:

1. The image name, point number and species number is entered into the DATA spreadsheet and;

2. The Image name, score date and the code file used is entered into the SCORE_DATE spreadsheet.

The additional data workbooks are stored in the following directory location:
R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\Image_scoring\LISA\AdditionalData

The formatting of these spreadsheets must be followed exactly for successful uploading into the TAFI Marine Biodiversity Database.

2.7 Instructions for adding new species to the UNID species catalogue

The UNID species catalogue is an illustrated record of the new organisms that are scored in the CPCe analysis that do not have a suitable code already listed in the code file. New organisms are first added to the UNID catalogue, classified to a category and then added to the main species identification catalogues. The UNID species catalogue has remained in use to find new/unidentified species quickly as each new organism added to the catalogue is simply numbered sequentially. If an organism is ever deleted from the catalogue, or is merged with another, then the original assigned number is considered deleted too and is never used again. This prevents any issues with database entries and historical numbering and identification of organisms.

When a new organism is found, a copy of the image is made and renamed with either "Copy_" or "C_" at the start of the file name. These images are stored in:

R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV\Image_scoring\LISA\ImageIDs\New images

The organism is labelled 'UNID *X*', with the number following sequentially in the catalogue. It is useful for future reference to make a note under the new image of the transect name that the image comes from.

An edited (cropped, enhanced etc) copy of the image, or a neighbouring image to show the new organism as clearly as possible, is then placed in the appropriate species catalogue. More than one image for any one organism is often helpful in species identification, particularly if the organism is found in different regions.

3. AUV Database

3.1 Overview

The AUV surveys and the image scoring process generate a large volume of data that need to be linked to facilitate data analysis. For this purpose a SQL Server database with a user friendly front-end for uploading and downloading data was created and is maintained by the IMAS data manager, Peter Walsh, on the IMAS server. The database links positional information collected *in situ* for each image in a transect (e.g. depth, altitude, latitude, longitude) with abiotic and biotic data from scored images. The database also contains a number of additional tables categorising 'species' for analysis purposes. At the highest level species are assigned reporting groups (biological, substrate, unscorable). Biological species are also assigned broad taxonomic groups (e.g. Porifera, Cnidaria, Crinoidea, etc, Table 7.) based on groupings used in other marine biodiversity databases held in IMAS (e.g. the long-term MPA monitoring dataset); algae are assigned habitat groups (canopy, understorey, encrusting); cnidarians are assigned functional groups (e.g. gorgonian, sea whip etc.) and sponges are assigned broad morphological groups (e.g. arborescent, cup, encrusting etc.). The provision for compatibility between the biological scoring scheme used here with those of collaborators (CSIRO and GA) is provided through tables that link GA and CSIRO classifications with the species scored in the AUV images. However, these tables have not been populated to date. The full schema of the AUV database is provided in Appendix C. Additional tables can be added as required by the Data Manager.

The following sections describe the process of uploading data to the AUV database. For permission to access and upload data please see the Data Manager.

Table 7. Species taxonomic groups used in the Marine Biodiversity Database

Group Code	Phylum	Class
AA	Chordata	Actinopterygii
AE	Chordata	Elasmobranchii
AM	Chordata	Mammalia
AR	Chordata	Reptilia
AV	Chordata	Aves
CC	Arthropoda	Cirripedia
CM	Arthropoda	Malacostraca
CT	Ctenophora	
EA	Echinodermata	Asteroidea
EC	Echinodermata	Crinoidea
EE	Echinodermata	Echinoidea
EH	Echinodermata	Holothuroidea
EO	Echinodermata	Ophiuroidea
EZ	Echinodermata	
MB	Mollusca	Bivalvia
MC	Mollusca	Cephalopoda
MG	Mollusca	Gastropoda
MO	Mollusca	Opisthobranchia
MP	Mollusca	Polyplacophora
MZ	Mollusca	
SP	Porifera	
TA	Cnidaria	Anthozoa
TB	Bryozoa	
TH	Cnidaria	Hydrozoa
TP	Platyhelminthes	Marine flatworms
TS	Cnidaria	Scyphozoa
TT	Chordata	Ascidiacea
TW	Annelida	Polychaeta
TZ	Animalia	
UB	Brachiopoda	
V	Substrate	
Z	Algae	
ZB	Ochrophyta	Phaeophyceae
ZG	Chlorophyta	
ZR	Rhodophyta	
ZS	Magnoliophyta	Liliopsida

3.2 Uploading transect information to the AUV database

In order to upload biological data from scored AUV images, data relating to the transect and the spatial location of the images contained within the transect first need to be uploaded into the 'AUV transect' folder of the TAFI Marine Biodiversity Database. Outlined below are the steps for uploading this information from the raw mission data files.

STEP 1- preparing a data file for upload:

- Find the transect that you wish to upload on the R drive. Usually located within the following folder: R:\TAFI\TAFI_MRL_Sections\Marine Environment\CERF\AUV
- Within thetransect folder open sub folder 'track_files' and save a copy the '…_latlong.csv' file as an .xls file (must be .xls extension). In the 2008 missions this file is located under the main transect folder, not in a subfolder.
- Open the file and remove any extra information that appears at the top of the file (such as notes) so that the first row contains the column headers.
- Make sure that the column headers match and are in the same order as below:

year month day hour minute second northing easting depth

latitude longitude roll pitch heading altitude leftimage rightimage

- In the 'leftimage' and 'rightimage' columns find and replace the file name extension 'png' with 'jpg'.
- Click on the tab at the bottom of the worksheet and rename it as 'Data'.

STEP 2- Uploading file to the database:

- Open 'AUV transects' folder in the TAFI Marine Biodiversity Database. Note: to upload data you need to have permission to do so (see the Data Manager Peter Walsh).
- In the toolbar, click on 'New' and the 'AUV Transect Import' form appears (Fig. 14):

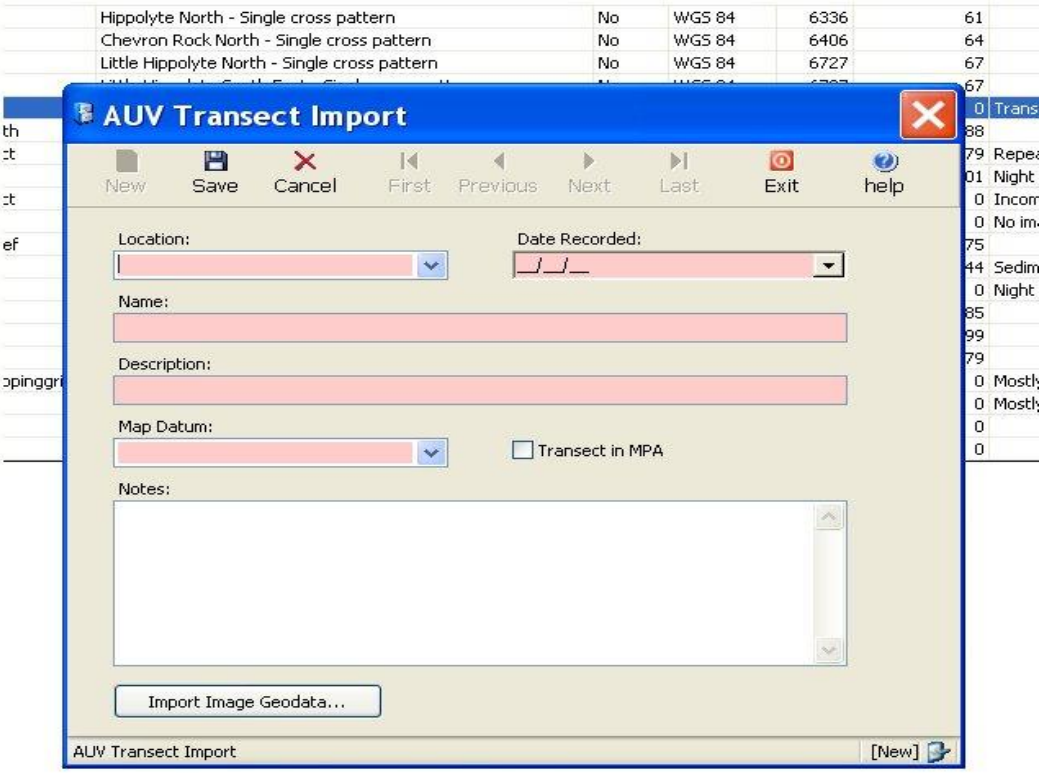

Fig. 14. The AUV transect import form for entering transect data into the Marine Biodiversity Database.

- In the 'Location' tab select the location of the transect you wish to import from the drop down menu.
- Use the drop down calendar to fill in the 'Date Recorded'.
- Enter the name of the transect you wish to import. This is generally in the format 'yymmdd_time_site_descriptor' and this should be the same as the folder names for that transect.
- Enter a useful description of the format of the transect (e.g. "*Location of transect* – double-cross pattern").
- Use the drop down menu to assign a map datum for the geographical data.
- If the transect falls within a state or commonwealth MPA check this box.
- Enter any notes relevant to the mission.
- Save this information.
- Click on 'Import Image Geodata' and find the modified Excel file.
- The file will be checked for errors and if there are no errors the message "Upload Completed" should appear.
- Double check that the transect and the associated information now appear in the 'AUV transects' table.

3.3 Uploading CPCe scored image data to the AUV database

Outlined below are the steps required to upload the CPCe summary data and the Additional Data spreadsheets, from the scored AUV images, to the Marine Biodiversity Database:

- Ensure the import spreadsheets conform to expected format and all required data exists (refer to Section 2.3.8).
- Log onto the Marine Biodiversity Database.
- Under 'AUV Data', select 'AUV Import' (Fig. 15).
- The 'Import AUV Image Bioscore Spreadsheet' window displays (Fig. 16).
- Navigate to the file location of the 'Unidentified Species Spreadsheet' by clicking the Open button (this refers to the 'AdditionalData_*TransectName*.xls' spreadsheet).
- Navigate to the file location of the 'Import Spreadsheet' by clicking the Open button (this refers to the CPCe data summary spreadsheet).
- If there are no errors found the Import button will then be highlighted; click 'Import'.

Prior to importing data, the database automatically checks:

- that data for each image has not already been imported; and
- cross-checks the spreadsheets that all the data is correct and present in the two spreadsheets.

If there are no errors the data can be immediately uploaded to the database, as the Import button will be highlighted. If there are any errors present the data cannot be imported and the database provides a list of the errors, with the corresponding image name/s and specific data points where the errors occurred. The errors must then be rectified and the importing process started again.

The types of errors that may be encountered are:

- the summary data has an UNID category for a data point and the corresponding information is absent from the Additional Data sheet;
- a point in an image has not been scored, including data missing from the Notes section for the first five points.

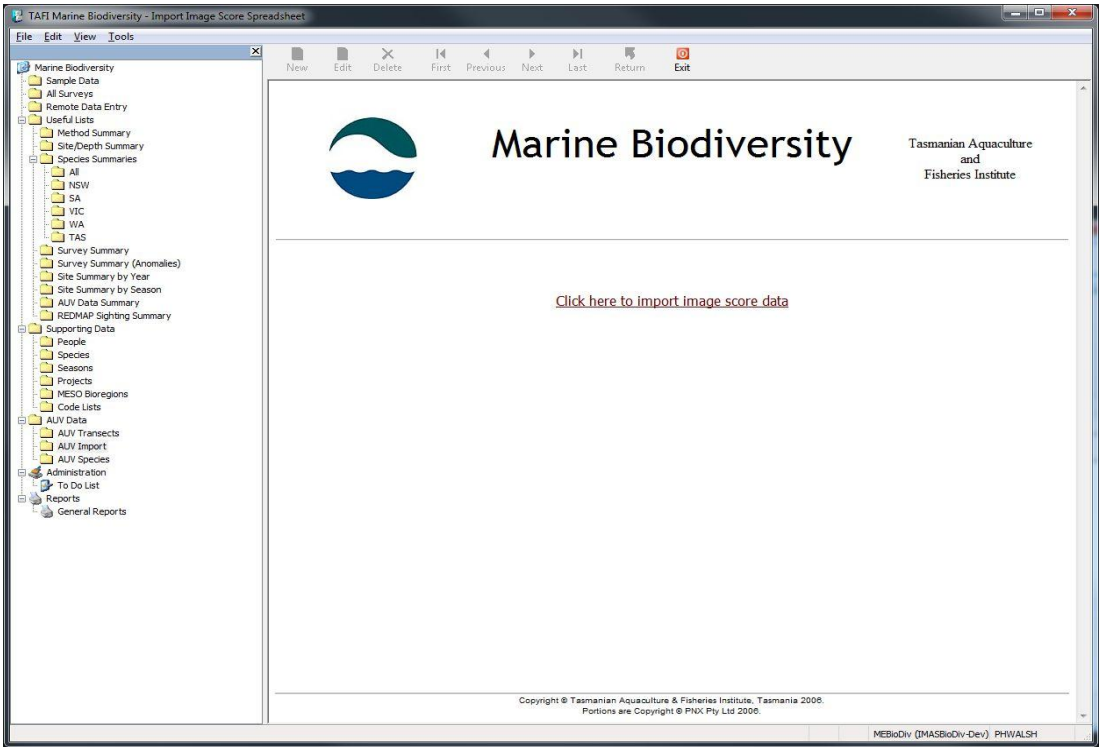

Fig. 15. The main screen of the Marine Biodiversity Database.

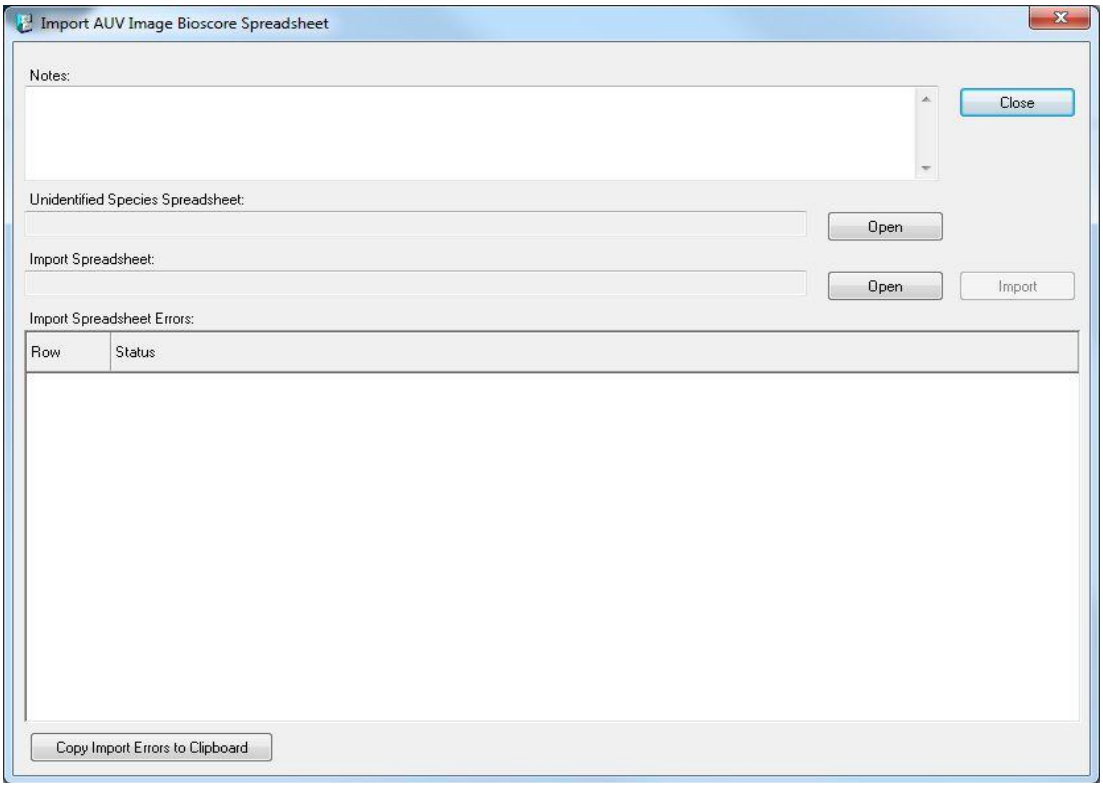

Fig. 16. The AUV Data import form for entering scored image data into the Marine Biodiversity Database.

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6. Appendix A

6.1 Descriptions of the codes used to categorise additional information for each AUV image (Points 1 to 5).

1: SCORER ID

ID	Code	Name
1	JH	Justin Hulls
2	JS	Jan Seiler
3	NB	Neville Barrett
4	NH	Nicole Hill
5	LM	Lisa Meyer
6	JD	Jo Dowdney
7	PV	Pauline Vouriot

2: RUGOSITY

Code	Description	Notes
1	Flat	Flat
2	Low Rugosity	Undulations to 0.5 m visible within frame, few obvious crevices
3	Moderate Rugosity	Relief to 1 m with or without obvious crevice structure, or lower relief, but with clear crevice structure (such as a boulder-field)
4	High Rugosity	Relief in excess of 1 m

3: SUBSTRATE

Code	Description	Notes
1	Mud	Mud
2	Sand	Sand
3	Coarse Sand	Including visible shell bits (sand 2-4 mm)
4	Cobble	Rocks with diameter >64mm and <256 mm (estimated)
5	Rock	Contiguous reef
6	Boulders	Rocks with diameter >256 mm (estimated)
7	Patchy Reef/Sand	Reef interspersed with sand patches
8	Screw Shells	Screw shells – only use if 100% cover
9	Sediment veneer on hard substrate	Appears to be sediment but has underlying hard-substrate structure and/ or reef associated organisms
10	Gravel	Loose rock with diameter >2mm and <64mm

4: FORM/SLOPE

Code	Description	Notes
1	Flat	Also used for flat sand
2	Low – Moderate slope	
3	Steep - Vertical Slope	
4	Ripples	Sand: Small sand features
5	Waves	Sand: Large sand forms with defined crests
6	Pit/Mounds	Sand: Bioturbations, Animal depressions/mounds

5: SPONGE SIZE

Code	Description	Notes
1	No sponges	No sponges
2	Low profile	Generally low profile, sponges <10 cm
3	Moderate profile	Medium canopy structure, sponges b/w 10-20 cm
4	High profile	High canopy contribution, sponges >20 cm

7. Appendix B

7.1 List of biota scored in AUV images and the associated categories and codes.

Code	Taxonomic Group	Report Group	Description	Habitat Group	Sponge Morphology Group	Coral Morphology Group
TURF	Algae	Biological	Turfing algae	Understorey		
DRIFT	Algae	Biological	Drift algae			
UNA	Algae	Biological	Unknow algae/seaweed			
UNK	Animalia	Biological	Unknown Biology			
TW1	Annelida, Polychaeta	Biological	Tube Worm sp1			
UNID34	Annelida, Polychaeta	Biological	Unidentified Species No 34			
BRY1	Bryozoa	Biological	Bryozoan 1 Steginoprella like			
BRY2	Bryozoa	Biological	Bryozoan 2 soft Amathia like			
BRY3	Bryozoa	Biological	Bryozoan 3 Cantinicella like			
BRY5	Bryozoa	Biological	Bryozoan 5 soft Orthoscuticella like			
BRY4	Bryozoa	Biological	Bryozoan 4 hard Celleporaria like			
UNID109	Bryozoa	Biological	Unidentified Species No 109			
UNID165	Bryozoa	Biological	Unidentified Species No 165			
CAL	Chlorophyta	Biological	Caulerpa spp	Understorey		
COD	Chlorophyta	Biological	Codium spp	Understorey		
GO	Chlorophyta	Biological	Green other spp	Understorey		
UNID50	Chlorophyta	Biological	Unidentified Species No 50	Understorey		
FISH	Chordata, Actinopterygii	Biological	Fish			
A7Sol	Chordata, Ascidiacea	Biological	Ascidian 7 Solitary			
A8O	Chordata, Ascidiacea	Biological	Ascidian 8 Others			
A1Cl	Chordata, Ascidiacea	Biological	Ascidian 1 Clavelina like			
A2Cl	Chordata, Ascidiacea	Biological	Ascidian 2 Clavelina like			
AS3O	Chordata, Ascidiacea	Biological	Ascidian 3 orange			
A4Sy	Chordata, Ascidiacea	Biological	Ascidian 4 Sycozoa like			
A5Sol	Chordata, Ascidiacea	Biological	Ascidian 5 Solitary			
A6R	Chordata, Ascidiacea	Biological	Ascidian 6 Red throated			
UNID117	Chordata, Ascidiacea	Biological	Unidentified Species No 117			
UNID15	Chordata, Ascidiacea	Biological	Unidentified Species No 15			
UNID16	Chordata, Ascidiacea	Biological	Unidentified Species No 16			
UNID29	Chordata, Ascidiacea	Biological	Unidentified Species No 29			
UNID5	Chordata, Ascidiacea	Biological	Unidentified Species No 5			
UNID7	Chordata, Ascidiacea	Biological	Unidentified Species No 7			

Code	Taxonomic Group	Report Group	Description	Habitat Group	Sponge Morphology Group	Coral Morphology Group
C4BR	Cnidaria, Anthozoa	Biological	bramble Asperaxis kareni			Bramble Corals
C3BR	Cnidaria, Anthozoa	Biological	bramble Acabaria sp			Bramble Corals
G1P	Cnidaria, Anthozoa	Biological	Gorgonian pink 1			Gorgonians
G2R	Cnidaria, Anthozoa	Biological	Gorgonian red 2			Gorgonians
SPEN	Cnidaria, Anthozoa	Biological	Sea Pen			Sea Pen
SW1	Cnidaria, Anthozoa	Biological	Sea whip 1			Sea Whips
C2S	Cnidaria, Anthozoa	Biological	Coral 2 soft Capnella like			Soft Corals
C6SB	Cnidaria, Anthozoa	Biological	Coral 6 soft blue			Soft Corals
C7SY	Cnidaria, Anthozoa	Biological	Coral 7 soft coral			Soft Corals
PARA1	Cnidaria, Anthozoa	Biological	Parazoanthus 1			Soft Corals
C5OS	Cnidaria, Anthozoa	Biological	Coral orange solitary			Solitary Hard Corals
ANEM1	Cnidaria, Anthozoa	Biological	Anemone sp1			
HYD1	Cnidaria, Hydrozoa	Biological	Hydroid 1			
UNID101	Cnidaria, Hydrozoa	Biological	Unidentified Species No 101			
UNID82	Cnidaria, Hydrozoa	Biological	Unidentified Species No 82			
UNID85	Cnidaria, Hydrozoa	Biological	Unidentified Species No 85			
UNID8	Ctenophora	Biological	Unidentified Species No 8			
SS	Echinodermata, Asteroidea	Biological	Sea star			
CENOL	Echinodermata, Crinoidea	Biological	Cenolia spp			
URCH	Echinodermata, Echinoidea	Biological	Urchins			
HOL	Echinodermata, Holothuroidea	Biological	Holothuroidea			
BS	Echinodermata, Ophiuroidea	Biological	Brittle star			
BOCF	Heterokontophyta, Phaeophyceae	Biological	Brown other canopy forming sp	Canopy		
ECK	Heterokontophyta, Phaeophyceae	Biological	Ecklonia radiata	Canopy		
PHY	Heterokontophyta, Phaeophyceae	Biological	Phyllospora spp	Canopy		
SAR	Heterokontophyta, Phaeophyceae	Biological	Sargassum sp	Canopy		
BUST	Heterokontophyta, Phaeophyceae	Biological	Brown Understory algae	Understorey		
SCAL	Mollusca, Bivalvia	Biological	Scallop			
MOL	Mollusca, Gastropoda	Biological	Mollusc			
ABAL	Mollusca, Gastropoda	Biological	Abalone			
NZSS	Mollusca, Gastropoda	Biological	Screw Shell			
UNID32	Platyhelminthes	Biological	Unidentified Species No 32			
A2GR	Porifera	Biological	Arborescent 2 grey		Arborescent	
A3PT	Porifera	Biological	Arborescent 3 purple thin		Arborescent	
A4OF	Porifera	Biological	Arborescent 4 orange flat		Arborescent	
A5W	Porifera	Biological	Arborescent 5 white		Arborescent	
A6Y	Porifera	Biological	Arborescent 6 yellow		Arborescent	
A7PU	Porifera	Biological	Arborescent 7 purple		Arborescent	
A8T	Porifera	Biological	Arborescent 8 tan		Arborescent	

Code	Taxonomic Group	Report Group	Description	Habitat Group	Sponge Morphology Group	Coral Morphology Group
A9OT	Porifera	Biological	Arborescent 9 orange thin		Arborescent	
A1WF	Porifera	Biological	Arborescent 1 white flat		Arborescent	
A10F	Porifera	Biological	Arborescent 10 orange/brown fingers		Arborescent	
A11OF	Porifera	Biological	Arborescent 11 orange fan		Arborescent	
A12BT	Porifera	Biological	Arborescent 12 brown thorny		Arborescent	
A13O	Porifera	Biological	Arborescent 13 orange		Arborescent	
A14B	Porifera	Biological	Arborescent 14 black		Arborescent	
A15WS	Porifera	Biological	Arborescent 15 white short		Arborescent	
A16BT	Porifera	Biological	Arborescent 16 brown thick		Arborescent	
UNID10	Porifera	Biological	Unidentified Species No 10		Arborescent	
UNID110	Porifera	Biological	Unidentified Species No 110		Arborescent	
UNID156	Porifera	Biological	Unidentified Species No 156		Arborescent	
UNID159	Porifera	Biological	Unidentified Species No 159		Arborescent	
UNID170	Porifera	Biological	Unidentified Species No 170		Arborescent	
UNID20	Porifera	Biological	Unidentified Species No 20		Arborescent	
UNID26	Porifera	Biological	Unidentified Species No 26		Arborescent	
UNID45	Porifera	Biological	Unidentified Species No 45		Arborescent	
UNID51	Porifera	Biological	Unidentified Species No 51		Arborescent	
UNID59	Porifera	Biological	Unidentified Species No 59		Arborescent	
UNID64	Porifera	Biological	Unidentified Species No 64		Arborescent	
UNID71	Porifera	Biological	Unidentified Species No 71		Arborescent	
UNID95	Porifera	Biological	Unidentified Species No 95		Arborescent	
C1W	Porifera	Biological	Cup 1 white		Cup	
C2WF	Porifera	Biological	Cup 2 white frilly		Cup	
C3B	Porifera	Biological	Cup 3 blue		Cup	
C4BT	Porifera	Biological	Cup 4 blue thick		Cup	
C5R	Porifera	Biological	Cup 5 red		Cup	
C6PT	Porifera	Biological	Cup 6 pink thick		Cup	
C7LPFT	Porifera	Biological	Cup 7 light pink flat thick		Cup	
C8Y	Porifera	Biological	Cup 8 yellow		Cup	
UNID111	Porifera	Biological	Unidentified Species No 111		Cup	
UNID35	Porifera	Biological	Unidentified Species No 35		Cup	
UNID56	Porifera	Biological	Unidentified Species No 56		Cup	
UNID9	Porifera	Biological	Unidentified Species No 9		Cup	
E1OR	Porifera	Biological	Encrusting 1 orange		Encrusting	
E2OR	Porifera	Biological	Encrusting 2 light orange		Encrusting	
E3Y	Porifera	Biological	Encrusting 3 yellow		Encrusting	
E4BL	Porifera	Biological	Encrusting 4 blue		Encrusting	
E5BR	Porifera	Biological	Encrusting 5 brown		Encrusting	

Code	Taxonomic Group	Report Group	Description	Habitat Group	Sponge Morphology Group	Coral Morphology Group
E6WH	Porifera	Biological	Encrusting 6 white		Encrusting	
E7G	Porifera	Biological	Encrusting 7 green		Encrusting	
UNID124	Porifera	Biological	Unidentified Species No 124		Encrusting	
UNID129	Porifera	Biological	Unidentified Species No 129		Encrusting	
UNID136	Porifera	Biological	Unidentified Species No 136		Encrusting	
UNID137	Porifera	Biological	Unidentified Species No 137		Encrusting	
UNID151	Porifera	Biological	Unidentified Species No 151		Encrusting	
UNID152	Porifera	Biological	Unidentified Species No 152		Encrusting	
UNID168	Porifera	Biological	Unidentified Species No 168		Encrusting	
UNID24	Porifera	Biological	Unidentified Species No 24		Encrusting	
UNID88	Porifera	Biological	Unidentified Species No 88		Encrusting	
UNID99	Porifera	Biological	Unidentified Species No 99		Encrusting	
F1OR	Porifera	Biological	Fan 1 orange		Fan	
F10	Porifera	Biological	Fan 10 thick large oscules		Fan	
F11PT	Porifera	Biological	Fan 11 thick pink		Fan	
F13OF	Porifera	Biological	Fan 13 orange frilly		Fan	
F14WT	Porifera	Biological	Fan 14 white thin		Fan	
F15OT	Porifera	Biological	Fan 15 orange thorny		Fan	
F2BR	Porifera	Biological	Fan 2 brown		Fan	
F3OF	Porifera	Biological	Fan 3 orange flat		Fan	
F4PI	Porifera	Biological	Fan 4 pink		Fan	
F5PE	Porifera	Biological	Fan 5 peach		Fan	
F6Y	Porifera	Biological	Fan 6 yellow		Fan	
F7ORT	Porifera	Biological	Fan 7 orange thin blade		Fan	
F8BT	Porifera	Biological	Fan 8 blue thick		Fan	
F9ORT	Porifera	Biological	Fan 9 orange thick		Fan	
F12BT	Porifera	Biological	Fan 12 brown thin		Fan	
UNID100	Porifera	Biological	Unidentified Species No 100		Fan	
UNID103	Porifera	Biological	Unidentified Species No 103		Fan	
UNID107	Porifera	Biological	Unidentified Species No 107		Fan	
UNID114	Porifera	Biological	Unidentified Species No 114		Fan	
UNID158	Porifera	Biological	Unidentified Species No 158		Fan	
UNID167	Porifera	Biological	Unidentified Species No 167		Fan	
UNID169	Porifera	Biological	Unidentified Species No 169		Fan	
UNID25	Porifera	Biological	Unidentified Species No 25		Fan	
UNID44	Porifera	Biological	Unidentified Species No 44		Fan	
UNID47	Porifera	Biological	Unidentified Species No 47		Fan	
UNID53	Porifera	Biological	Unidentified Species No 53		Fan	
UNID54	Porifera	Biological	Unidentified Species No 54		Fan	

Code	Taxonomic Group	Report Group	Description	Habitat Group	Sponge Morphology Group	Coral Morphology Group
UNID55	Porifera	Biological	Unidentified Species No 55		Fan	
UNID68	Porifera	Biological	Unidentified Species No 68		Fan	
UNID75	Porifera	Biological	Unidentified Species No 75		Fan	
UNID76	Porifera	Biological	Unidentified Species No 76		Fan	
UNID83	Porifera	Biological	Unidentified Species No 83		Fan	
UNID87	Porifera	Biological	Unidentified Species No 87		Fan	
G1OR	Porifera	Biological	Globular 1 orange Tethya like		Globular	
G2WH	Porifera	Biological	Globular 2 white Tethya like		Globular	
G4O	Porifera	Biological	Globular 4 orange		Globular	
UNID11	Porifera	Biological	Unidentified Species No 11		Globular	
UNID33	Porifera	Biological	Unidentified Species No 33		Globular	
L1PS	Porifera	Biological	Lumpy 1 purple stumps		Lumpy	
L2O	Porifera	Biological	Lumpy 2 orange		Lumpy	
L3W	Porifera	Biological	Lumpy 3 white		Lumpy	
L4P	Porifera	Biological	Lumpy 4 pink		Lumpy	
L5Y	Porifera	Biological	Lumpy 5 yellow		Lumpy	
M18OH	Porifera	Biological	Massive 18 orange holey		Lumpy	
UNID104	Porifera	Biological	Unidentified Species No 104		Lumpy	
UNID105	Porifera	Biological	Unidentified Species No 105		Lumpy	
UNID106	Porifera	Biological	Unidentified Species No 106		Lumpy	
UNID113	Porifera	Biological	Unidentified Species No 113		Lumpy	
UNID115	Porifera	Biological	Unidentified Species No 115		Lumpy	
UNID12	Porifera	Biological	Unidentified Species No 12		Lumpy	
UNID120	Porifera	Biological	Unidentified Species No 120		Lumpy	
UNID128	Porifera	Biological	Unidentified Species No 128		Lumpy	
UNID13	Porifera	Biological	Unidentified Species No 13		Lumpy	
UNID130	Porifera	Biological	Unidentified Species No 130		Lumpy	
UNID133	Porifera	Biological	Unidentified Species No 133		Lumpy	
UNID134	Porifera	Biological	Unidentified Species No 134		Lumpy	
UNID140	Porifera	Biological	Unidentified Species No 140		Lumpy	
UNID141	Porifera	Biological	Unidentified Species No 141		Lumpy	
UNID142	Porifera	Biological	Unidentified Species No 142		Lumpy	
UNID143	Porifera	Biological	Unidentified Species No 143		Lumpy	
UNID145	Porifera	Biological	Unidentified Species No 145		Lumpy	
UNID148	Porifera	Biological	Unidentified Species No 148		Lumpy	
UNID154	Porifera	Biological	Unidentified Species No 154		Lumpy	
UNID155	Porifera	Biological	Unidentified Species No 155		Lumpy	
UNID172	Porifera	Biological	Unidentified Species No 172		Lumpy	
UNID19	Porifera	Biological	Unidentified Species No 19		Lumpy	

Code	Taxonomic Group	Report Group	Description	Habitat Group	Sponge Morphology Group	Coral Morphology Group
UNID2	Porifera	Biological	Unidentified Species No 2		Lumpy	
UNID21	Porifera	Biological	Unidentified Species No 21		Lumpy	
UNID28	Porifera	Biological	Unidentified Species No 28		Lumpy	
UNID31	Porifera	Biological	Unidentified Species No 31		Lumpy	
UNID36	Porifera	Biological	Unidentified Species No 36		Lumpy	
UNID39	Porifera	Biological	Unidentified Species No 39		Lumpy	
UNID41	Porifera	Biological	Unidentified Species No 41		Lumpy	
UNID52	Porifera	Biological	Unidentified Species No 52		Lumpy	
UNID57	Porifera	Biological	Unidentified Species No 57		Lumpy	
UNID61	Porifera	Biological	Unidentified Species No 61		Lumpy	
UNID63	Porifera	Biological	Unidentified Species No 63		Lumpy	
UNID78	Porifera	Biological	Unidentified Species No 78		Lumpy	
UNID84	Porifera	Biological	Unidentified Species No 84		Lumpy	
UNID86	Porifera	Biological	Unidentified Species No 86		Lumpy	
UNID93	Porifera	Biological	Unidentified Species No 93		Lumpy	
UNID97	Porifera	Biological	Unidentified Species No 97		Lumpy	
UNID98	Porifera	Biological	Unidentified Species No 98		Lumpy	
M1	Porifera	Biological	Massive 1		Massive	
M10BR	Porifera	Biological	Massive 10 brown		Massive	
M11WH	Porifera	Biological	Massive 11 white holey		Massive	
M12YP	Porifera	Biological	Massive 12 yellow papillate		Massive	
M13WP	Porifera	Biological	Massive 13 white papillate		Massive	
M14OR	Porifera	Biological	Massive 14 orange shapeless		Massive	
M15PS	Porifera	Biological	Massive 15 shapeless		Massive	
M16P	Porifera	Biological	Massive 16 purple		Massive	
M17WL	Porifera	Biological	Massive 17 white lumpy		Massive	
M19	Porifera	Biological	Massive 19 yellow shapeless		Massive	
M2	Porifera	Biological	Massive 2		Massive	
M20P	Porifera	Biological	Massive 20 pink		Massive	
M3OR	Porifera	Biological	Massive 3 orange		Massive	
M4DON	Porifera	Biological	Massive 4 donut		Massive	
M5	Porifera	Biological	Massive 5 fungi		Massive	
M6VEL	Porifera	Biological	Massive 6 velet		Massive	
M7BL	Porifera	Biological	Massive 7 blue		Massive	
M8	Porifera	Biological	Massive 8		Massive	
M9WH	Porifera	Biological	Massive 9 white		Massive	
UNID102	Porifera	Biological	Unidentified Species No 102		Massive	
UNID108	Porifera	Biological	Unidentified Species No 108		Massive	
UNID116	Porifera	Biological	Unidentified Species No 116		Massive	

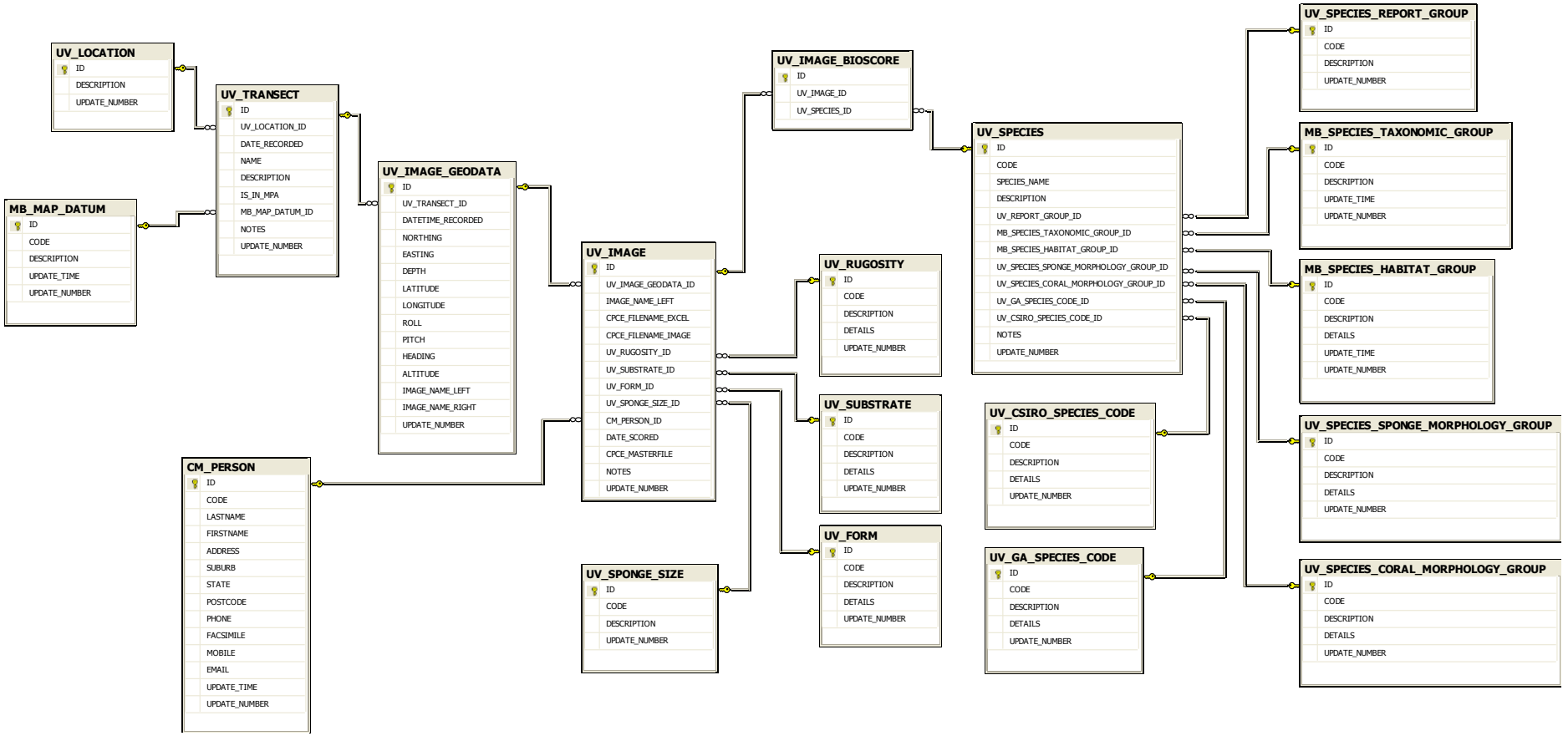
Code	Taxonomic Group	Report Group	Description	Habitat Group	Sponge Morphology Group	Coral Morphology Group
UNID121	Porifera	Biological	Unidentified Species No 121		Massive	
UNID123	Porifera	Biological	Unidentified Species No 123		Massive	
UNID126	Porifera	Biological	Unidentified Species No 126		Massive	
UNID132	Porifera	Biological	Unidentified Species No 132		Massive	
UNID135	Porifera	Biological	Unidentified Species No 135		Massive	
UNID139	Porifera	Biological	Unidentified Species No 139		Massive	
UNID14	Porifera	Biological	Unidentified Species No 14		Massive	
UNID144	Porifera	Biological	Unidentified Species No 144		Massive	
UNID146	Porifera	Biological	Unidentified Species No 146		Massive	
UNID157	Porifera	Biological	Unidentified Species No 157		Massive	
UNID164	Porifera	Biological	Unidentified Species No 164		Massive	
UNID171	Porifera	Biological	Unidentified Species No 171		Massive	
UNID18	Porifera	Biological	Unidentified Species No 18		Massive	
UNID22	Porifera	Biological	Unidentified Species No 22		Massive	
UNID37	Porifera	Biological	Unidentified Species No 37		Massive	
UNID40	Porifera	Biological	Unidentified Species No 40		Massive	
UNID42	Porifera	Biological	Unidentified Species No 42		Massive	
UNID46	Porifera	Biological	Unidentified Species No 46		Massive	
UNID49	Porifera	Biological	Unidentified Species No 49		Massive	
UNID58	Porifera	Biological	Unidentified Species No 58		Massive	
UNID60	Porifera	Biological	Unidentified Species No 60		Massive	
UNID62	Porifera	Biological	Unidentified Species No 62		Massive	
UNID89	Porifera	Biological	Unidentified Species No 89		Massive	
UNID92	Porifera	Biological	Unidentified Species No 92		Massive	
UNID96	Porifera	Biological	Unidentified Species No 96		Massive	
P1SU	Porifera	Biological	Papillate 1 Suberites like		Papillate	
P2Y	Porifera	Biological	Papillate 2 yellow		Papillate	
P3B	Porifera	Biological	Papillate 3 black		Papillate	
P4LO	Porifera	Biological	Papillate 4 light orange		Papillate	
UNID150	Porifera	Biological	Unidentified Species No 150		Papillate	
UNID161	Porifera	Biological	Unidentified Species No 161		Papillate	
UNID162	Porifera	Biological	Unidentified Species No 162		Papillate	
UNID166	Porifera	Biological	Unidentified Species No 166		Papillate	
UNID65	Porifera	Biological	Unidentified Species No 65		Papillate	
R1B	Porifera	Biological	Repent 1 brown		Repent	
UNID1	Porifera	Biological	Unidentified Species No 1		Repent	
UNID27	Porifera	Biological	Unidentified Species No 27		Repent	
UNID6	Porifera	Biological	Unidentified Species No 6		Repent	
G3BL	Porifera	Biological	Globular 3 blue		Tubular	

Code	Taxonomic Group	Report Group	Description	Habitat Group	Sponge Morphology Group	Coral Morphology Group
T7PT	Porifera	Biological	Tubualr 7 pink thorny		Tubular	
T1PI	Porifera	Biological	Tubular 1 pink		Tubular	
T10OT	Porifera	Biological	Tubular 10 orange thorny		Tubular	
T11B	Porifera	Biological	Tubular 11 blue		Tubular	
T12PO	Porifera	Biological	Tubular 12 pale orange		Tubular	
T13	Porifera	Biological	Tubular 13 Sycon		Tubular	
T14S	Porifera	Biological	Tubular 14 solitary		Tubular	
T2	Porifera	Biological	Tubular 2 apricot		Tubular	
T3WC	Porifera	Biological	Tubular 3 white colony		Tubular	
T4T	Porifera	Biological	Tubular 4 tan		Tubular	
T5	Porifera	Biological	Tubular 5 tan singular		Tubular	
T6WT	Porifera	Biological	Tubular 6 white thorny		Tubular	
T8OR	Porifera	Biological	Tubular 8 orange		Tubular	
T9PP	Porifera	Biological	Tubular 9 pink small oscules		Tubular	
UNID112	Porifera	Biological	Unidentified Species No 112		Tubular	
UNID125	Porifera	Biological	Unidentified Species No 125		Tubular	
UNID127	Porifera	Biological	Unidentified Species No 127		Tubular	
UNID131	Porifera	Biological	Unidentified Species No 131		Tubular	
UNID138	Porifera	Biological	Unidentified Species No 138		Tubular	
UNID147	Porifera	Biological	Unidentified Species No 147		Tubular	
UNID149	Porifera	Biological	Unidentified Species No 149		Tubular	
UNID153	Porifera	Biological	Unidentified Species No 153		Tubular	
UNID160	Porifera	Biological	Unidentified Species No 160		Tubular	
UNID163	Porifera	Biological	Unidentified Species No 163		Tubular	
UNID17	Porifera	Biological	Unidentified Species No 17		Tubular	
UNID3	Porifera	Biological	Unidentified Species No 3		Tubular	
UNID38	Porifera	Biological	Unidentified Species No 38		Tubular	
UNID4	Porifera	Biological	Unidentified Species No 4		Tubular	
UNID69	Porifera	Biological	Unidentified Species No 69		Tubular	
UNID81	Porifera	Biological	Unidentified Species No 81		Tubular	
ECOR	Rhodophyta	Biological	Encrusting coralline	Encrusting		
UNID30	Rhodophyta	Biological	Unidentified Species No 30	Encrusting		
RFOL	Rhodophyta	Biological	Red foliose	Understorey		
SOND	Rhodophyta	Biological	Sonderopelta spp. and Peyssionnelia spp.	Understorey		
THAM	Rhodophyta	Biological	Thamnoclonium	Understorey		
MATR		Biological	Biogenic Matrix			
BRUB		Substrate	Biological Rubble			
GRAV		Substrate	Pebble/Gravel			
BIOT		Substrate	Bioturbation			

Code	Taxonomic Group	Report Group	Description	Habitat Group	Sponge Morphology Group	Coral Morphology Group
ROCK		Substrate	Rock Substrate			
SAND		Substrate	Sand			
UNS		Unscorable	Unscorable			

8. Appendix C

8.1 Table descriptions and table relationships in the Marine Biodiversity Database (SQL Server).



8.2 Descriptions of the tables in the Marine Biodiversity Database relating to the AUV image analysis.

UV_TRANSECT
Contains information about AUV transects.
Keys

Key	Type	Related Table	Related Column
PK_UV_TRANSECT	Primary	N/A	N/A
FK_UV_TRANSECT_MB_MAP_DATUM	Foreign	MB_MAP_DATUM	ID
FK_UV_TRANSECT_UV_LOCATION	Foreign	UV_LOCATION	ID

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
UV_LOCATION_ID	int	10	0	NO	Foreign Key UV_LOCATION
DATE_RECORDED	date	10		NO	Date this transect was recorded
NAME	varchar	128		NO	Name of the transect - this must match the folder name used for storage of data (currently on the R: drive). This is only one folder deep. eg. r20081006_231255_waterfall_05_transect
DESCRIPTION	varchar	256		NO	Transect description
IS_IN_MPA	smallint	5	0	NO	Transect is in an MPA. 1=Yes/2=No
MB_MAP_DATUM_ID	int	10	0	NO	Foreign Key MB_MAP_DATUM
NOTES	text	MAX		YES	Notes
UPDATE_NUMBER	int	10	0	NO	Update Number

MB_MAP_DATUM
Datum used to record geographic location of images (e.g. WGS84).
Keys

Key	Type	Related Table	Related Column
PK_MB_MAP_DATUM	Primary	N/A	N/A

Columns

Fieldname	**Type**	**Size**	**Scale**	**Null**	**Comment**
ID	int identity	10	0	NO	
CODE	Varchar	3		NO	
DESCRIPTION	varchar	50		NO	
UPDATE_TIME	datetime	23	3	NO	
UPDATE_NUMBER	int	10	0	NO	

UV_LOCATION
Contains details of broad geographic locations of each AUV transect survey.
Keys

Key	Type	Related Table	Related Column
PK_UV_LOCATION	Primary	N/A	N/A

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
DESCRIPTION	varchar	50		NO	Location description
UPDATE_NUMBER	int	10	0	NO	Update Number

UV_IMAGE_GEODATA
Contains positioning information collected for all images recorded in a transect.

Some notes on data in this table from Duncan Mercer (Australian Centre for Field Robotics, University of Sydney) on 11/3/2010:
The values for pitch, roll (and heading) are given in radians +/- Pi, so the values should be rather smaller than you are expecting in degrees. That said the vehicle is extremely stable in both pitch and roll. It was designed to be a camera platform and as such a premium was placed on stability in both pitch and roll. If you have seen the vehicle you will have noticed that it is "tall" and "long". All of the buoyancy is contained in the upper shell, and most of the weight in the lower shell, this provides roll stability, the length provides the pitch stability. The values for pitch and roll are provided by the RDI workhorse DVL (ADCP), whilst we make no attempt to calibrate these values if there were any significant discrepancy in these numbers we would see the problem in our image analysis suite. Using the 3D pairs we can extract relative pitch, roll, heading, X-Y offset between image pairs, problems with the pitch and roll would show up here and prevent us from constructing our 3D surfaces.

In engineering terms it makes sense to treat headings in a manner similar to pitch and roll, IE the numbers are in the range +/- Pi radians. This corresponds to a range -180 deg -> +180 degrees. If you want a conventional (0->360) heading in degrees, you need to convert to degrees, then if heading < 0, add 360.

Eastings and Northings are given in a custom projected local co-ordinate frame. They do not map to any conventional UTM projection etc and are not valid in any global frame. They are what we use to navigate.

More from Duncan on 15/3/2010:
WRT to the csv files that we have been providing from the AUV dives, I have latterly found that we are providing heading / pitch / roll values in a reference frame which is not the standard one that you might expect to see.

The reference frame that was used is one for the imagery and not as you'd expect the vehicle reference frame.

The upshot is that to correct the provided heading to get to the vehicle heading you need to subtract Pi/2. The pitch and roll values are rather more involved, given that they are approximately zero it is safest and easiest to assume zero rather than try and make a convoluted conversion.

To re-iterate, what is in the files that you have is, X,Y,Z, position of the centre of left image, along with heading pitch and roll data in a camera frame.

What you might need to convert to is X,Y,Z, position of the centre of the left image, along with heading of the vehicle (subtract Pi/2).

More from Duncan on 24/3/2010:
Easting / Northing:- these are relative E/N, relative to the "dive origin". This origin is an arbitrary point chosen for the particular survey being conducted. The E/N values are derived from a UTM projection, so are completely general, and can be used to interpret local motion, but should not be used in a global sense. Indeed these E/N values are what the vehicle uses as it's primary means of navigating whilst underway.

Roll / Pitch:- I think it's best to label these in your data sets as "should not be used". As I mentioned before these values are not at all what you would expect from the labels. It is possible to convert these values back to a standard vehicle-centered pitch / roll, but this involves some pretty messy changes in co-ordinate frames, and euler angles etc.

Future versions of these CSV files will have the appropriate, vehicle-centered pitch and roll, and much improved comments and headers.

Keys

Key	Type	Related Table	Related Column
PK_UV_IMAGE_GEODATA	Primary	N/A	N/A
FK_UV_IMAGE_GEODATA_UV_TRANSECT	Foreign	UV_TRANSECT	ID

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
UV_TRANSECT_ID	int	10	0	NO	Foreign Key UV_TRANSECT
DATETIME_RECORDED	datetime	23	3	NO	Recording date/time for this image
NORTHING	numeric	18	2	NO	Northing
EASTING	numeric	18	2	NO	Easting
DEPTH	numeric	18	2	NO	Depth of the AUV unit (m)
LATITUDE	numeric	18	9	NO	Latitude
LONGITUDE	numeric	18	9	NO	Longitude
ROLL	int	10	0	NO	See table description
PITCH	int	10	0	NO	See table description
HEADING	int	10	0	NO	See table description
ALTITUDE	int	10	0	NO	Altitude - height above the sea floor of the AUV unit (m)
IMAGE_NAME_LEFT	varchar	128		NO	Name of the left image (must be unique)
IMAGE_NAME_RIGHT	varchar	128		NO	Name of the right image (must be unique)
UPDATE_NUMBER	int	10	0	NO	Update Number

CM_PERSON

Name and details of the person scoring AUV images.

Keys

Key	**Type**	**Related Table**	**Related Column**
PK_CM_PERSON	Primary	N/A	N/A

Columns

Fieldname	**Type**	**Size**	**Scale**	**Null**	**Comment**
ID	int identity	10	0	NO	
CODE	char	5		NO	
LASTNAME	char	50		NO	
FIRSTNAME	char	50		YES	
ADDRESS	char	255		YES	
SUBURB	char	50		YES	
STATE	char	3		YES	
POSTCODE	char	4		YES	
PHONE	char	20		YES	
FACSIMILE	char	20		YES	
MOBILE	char	20		YES	
EMAIL	char	255		YES	
UPDATE_TIME	datetime	23	3	NO	
UPDATE_NUMBER	int	10	0	NO	

UV_IMAGE

Contains information at the image level for all images that have been scored. Note: biological data scored are contained in a separate table. Not all images in UV_IMAGE_GEODATA are scored (approximately 1 in 100 at time of writing).

Keys

Key	Type	Related Table	Related Column
PK_UV_IMAGE	Primary	N/A	N/A
FK_UV_IMAGE_CM_PERSON	Foreign	CM_PERSON	ID
FK_UV_IMAGE_UV_FORM	Foreign	UV_FORM	ID
FK_UV_IMAGE_UV_IMAGE_GEODATA	Foreign	UV_IMAGE_GEODATA	ID
FK_UV_IMAGE_UV_RUGOSITY	Foreign	UV_RUGOSITY	ID
FK_UV_IMAGE_UV_SPONGE_SIZE	Foreign	UV_SPONGE_SIZE	ID
FK_UV_IMAGE_UV_SUBSTRATE	Foreign	UV_SUBSTRATE	ID

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
UV_IMAGE_GEODATA_ID	int	10	0	NO	Foreign Key UV_IMAGE_GEODATA
IMAGE_NAME_LEFT	varchar	128		NO	Image name. Corresponds to UV_IMAGE_GEODATA.IMAGE_NAME_LEFT (which must exist for this name). Used to create the foreign key UV_IMAGE_GEODATA_ID.
CPCE_FILENAME_EXCEL	varchar	128		NO	CPCe Excel filename containing scores for this image
CPCE_FILENAME_IMAGE	varchar	128		NO	CPCe Image filename (may be different to IMAGE_NAME_LEFT and will have a .cpce extenstion)
UV_RUGOSITY_ID	int	10	0	NO	Foreign Key UV_RUGOSITY
UV_SUBSTRATE_ID	int	10	0	NO	Foreign Key UV_SUBSTRATE
UV_FORM_ID	int	10	0	NO	Foreign Key UV_FORM
UV_SPONGE_SIZE_ID	int	10	0	YES	Foreign Key UV_SPONGE_SIZE
CM_PERSON_ID	int	10	0	NO	Foreign Key CM_PERSON. Person who scored this image.
DATE_SCORED	date	10		NO	Date this image was scored
CPCE_MASTERFILE	varchar	128		NO	Name of the master file used to determine species codes etc.
NOTES	text	MAX		YES	Notes
UPDATE_NUMBER	int	10	0	NO	Update Number

UV_IMAGE_BIOSCORE

Contains score information about species found under a randomly generated point on an image. Note: there are 50 points scored per image.

Keys

Key	Type	Related Table	Related Column
PK_UV_IMAGE_BIOSCORE	Primary	N/A	N/A
FK_UV_IMAGE_BIOSCORE_UV_IMAGE	Foreign	UV_IMAGE	ID
FK_UV_IMAGE_BIOSCORE_UV_SPECIES	Foreign	UV_SPECIES	ID

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
UV_IMAGE_ID	int	10	0	NO	Foreign Key UV_IMAGE. Identifies the image this score relates to.
UV_SPECIES_ID	int	10	0	NO	Foreign Key UV_SPECIES. Records the species for this point on the scored image.

UV_RUGOSITY
Contains information about rugosity categories normally assigned to AUV images.
Refer to Appendix A Section 2 for category descriptions.
Keys

Key	Type	Related Table	Related Column
PK_UV_RUGOSITY	Primary	N/A	N/A

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
CODE	varchar	3		NO	Code
DESCRIPTION	varchar	50		NO	Rugosity code description
DETAILS	text	MAX		YES	Details
UPDATE_NUMBER	int	10	0	NO	Update Number

UV_SUBSTRATE
Contains information about the classification of the primary substrate (>50% cover) observed in AUV images.
Keys

Key	Type	Related Table	Related Column
PK_UV_SUBSTRATE	Primary	N/A	N/A

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
CODE	varchar	3		NO	Code
DESCRIPTION	varchar	50		NO	Substrate description
DETAILS	text	MAX		YES	Details
UPDATE_NUMBER	int	10	0	NO	Update Number

UV_FORM
Contains information about substrate form/slope classification normally assigned to AUV images.
Refer to Appendix A Section 3 for category descriptions.
Keys

Key	Type	Related Table	Related Column
PK_UV_FORM	Primary	N/A	N/A

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
CODE	varchar	3		NO	Form code
DESCRIPTION	varchar	50		NO	Form description
DETAILS	text	MAX		YES	Details
UPDATE_NUMBER	int	10	0	NO	Update Number

UV_SPONGE_SIZE
Contains information about the classification of sponge communities observed in an image, based on an overall visual assessment (i.e. not scored under 50 random points). Refer to Appendix A Section 5 for categories and descriptions.
Keys

Key	Type	Related Table	Related Column
PK_UV_SPONGE_SIZE	Primary	N/A	N/A

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
CODE	varchar	3		NO	Code
DESCRIPTION	varchar	50		NO	Description
UPDATE_NUMBER	int	10	0	NO	Update Number

UV_SPECIES

Contains information about species detected in AUV images. Species are assigned to various taxonomic groupings, sponges to morphological categories (Table 6) etc. Refer to Section 2.5 for more information.

Keys

Key	Type	Related Table	Related Column
PK_UV_SPECIES	Primary	N/A	N/A
FK_UV_SPECIES_MB_SPECIES_HABITAT_GROUP	Foreign	MB_SPECIES_HABITAT_GROUP	ID
FK_UV_SPECIES_MB_SPECIES_TAXONOMIC_GROUP	Foreign	MB_SPECIES_TAXONOMIC_GROUP	ID
FK_UV_SPECIES_UV_CSIRO_SPECIES_CODE	Foreign	UV_CSIRO_SPECIES_CODE	ID
FK_UV_SPECIES_UV_GA_SPECIES_CODE	Foreign	UV_GA_SPECIES_CODE	ID
FK_UV_SPECIES_UV_REPORT_GROUP	Foreign	UV_SPECIES_REPORT_GROUP	ID
FK_UV_SPECIES_UV_SPECIES_CORAL_MORPHOLOGY_GROUP	Foreign	UV_SPECIES_CORAL_MORPHOLOGY_GROUP	ID
FK_UV_SPECIES_UV_SPECIES_SPONGE_MORPHOLOGY_GROUP	Foreign	UV_SPECIES_SPONGE_MORPHOLOGY_GROUP	ID

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
CODE	int	10	0	NO	Species code
SPECIES_NAME	varchar	128		YES	Taxanomic species name
DESCRIPTION	varchar	50		NO	Species description
UV_REPORT_GROUP_ID	int	10	0	NO	Foreign Key UV_REPORT_GROUP
MB_SPECIES_TAXONOMIC_GROUP_ID	int	10	0	NO	Foreign Key MB_SPECIES_TAXONOMIC_GROUP.
MB_SPECIES_HABITAT_GROUP_ID	int	10	0	YES	Foreign Key MB_SPECIES_HABITAT_GROUP
UV_SPECIES_SPONGE_MORPHOLOGY_GROUP_ID	int	10	0	YES	Foreign Key UV_SPONGE_MORPHOLOGY_GROUP
UV_SPECIES_CORAL_MORPHOLOGY_GROUP_ID	int	10	0	YES	Foreign Key UV_SPECIES_CORAL_MORPHOLOGY_GROUP
UV_GA_SPECIES_CODE_ID	int	10	0	YES	Foreign Key UV_GA_SPECIES_CODE
UV_CSIRO_SPECIES_CODE_ID	int	10	0	YES	Foreign Key UV_CSIRO_SPECIES_CODE
NOTES	text	MAX		YES	Notes
UPDATE_NUMBER	int	10	0	NO	Update Number

UV_SPECIES_REPORT_GROUP

Contains information about broadest categories assigned to species – i.e. 'Biological' or 'Substrate' used for sorting data for analyses.

Keys

Key	Type	Related Table	Related Column
PK_UV_REPORT_GROUP	Primary	N/A	N/A

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
CODE	varchar	3		NO	Code
DESCRIPTION	varchar	50		NO	Report group description
UPDATE_NUMBER	int	10	0	NO	Update Number

MB_SPECIES_TAXONOMIC_GROUP

Contains broad taxonomic group for each species (e.g. Bryozoa, Porifera, Rhodophyta etc). The table is the same as that used in the long-term monitoring database (Marine Biodiversity Database).

Keys

Key	Type	Related Table	Related Column
PK_MB_SPECIES_TAXONOMIC_GROUP	Primary	N/A	N/A

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int identity	10	0	NO	
CODE	varchar	3		NO	
DESCRIPTION	varchar	50		NO	
UPDATE_TIME	datetime	23	3	NO	
UPDATE_NUMBER	int	10	0	NO	Update Number

MB_SPECIES_HABITAT_GROUP

Habitat descriptor for algal species (i.e. Canopy, Understory, Encrusting). The Table originates from the long-term monitoring database (Marine Biodiversity Database).

Keys

Key	Type	Related Table	Related Column
PK_MB_SPECIES_HABITAT_GROUP	Primary	N/A	N/A

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int identity	10	0	NO	Primary Key
CODE	varchar	3		NO	Code
DESCRIPTION	varchar	50		NO	Description
DETAILS	varchar	2048		YES	
UPDATE_TIME	datetime	23	3	NO	Update time for remote database synchronisation
UPDATE_NUMBER	int	10	0	NO	Update Number

UV_SPECIES_SPONGE_MORPHOLOGY_GROUP

Contains information about broad morphological categories assigned to species within the taxonomic group Porifera. Categories include Arborescent, Cup, Encrusting etc (refer to Table 6 in Section 2.5 for more information) and were based on morphological categories described in Boury-Esnault and Rützler (1997) and Bell and Barnes (2001).

Keys

Key	Type	Related Table	Related Column
PK_UV_SPECIES_SPONGE_MORPHOLOGY_GROUP	Primary	N/A	N/A

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
CODE	varchar	3		NO	Code
DESCRIPTION	varchar	50		NO	Description
DETAILS	varchar	2048		YES	
UPDATE_NUMBER	int	10	0	NO	Update Number

UV_SPECIES_CORAL_MORPHOLOGY_GROUP

Contains broad categories assigned to species' within the taxonomic group Cnidaria. Categories include gorgonian, soft coral and hard coral. Refer to Section 2.5 for more information.

Keys

Key	Type	Related Table	Related Column
PK_UV_SPECIES_CORAL_MORPHOLOGY_GROUP	Primary	N/A	N/A

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
CODE	varchar	3		NO	Code
DESCRIPTION	varchar	50		NO	Description
DETAILS	varchar	2048		YES	
UPDATE_NUMBER	int	10	0	NO	Update Number

UV_GA_SPECIES_CODE

Contains equivalent species codes and descriptions used by Geosciences Australia (GA).

Keys

Key	Type	Related Table	Related Column
PK_UV_GA_SPECIES_CODE	Primary	N/A	N/A

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
CODE	varchar	3		NO	Code
DESCRIPTION	varchar	50		NO	Description
DETAILS	varchar	2048		YES	
UPDATE_NUMBER	int	10	0	NO	Update Number

UV_CSIRO_SPECIES_CODE

Contains equivalent species codes and descriptions used in the CSIRO image scoring system for each species. Note: this table has not been populated to date.

Keys

Key	Type	Related Table	Related Column
PK_UV_CSIRO_SPECIES_CODE	Primary	N/A	N/A

Columns

Fieldname	Type	Size	Scale	Null	Comment
ID	int	10	0	NO	Primary Key
CODE	varchar	3		NO	Code
DESCRIPTION	varchar	50		NO	Description
DETAILS	varchar	2048		YES	
UPDATE_NUMBER	int	10	0	NO	Update Number

The Institute for Marine and Antarctic Studies (IMAS), established in 2010, comprises the University of Tasmania's internationally recognised expertise across the full spectrum of temperate marine, Southern Ocean, and Antarctic research and education.

CONTACT US:

IMAS is currently located at two main campuses:

Sandy Bay:
Physical Address
IMAS-Sandy Bay
Building 49 (between the Law Building and the University Gym)
Cnr Alexander St/Grosvenor St
Sandy Bay TAS 7005
Australia

Postal Address:
IMAS-Sandy Bay
Private Bag 129, Hobart TAS 7001
Telephone: (03) 6226 2937

Taroona:
Physical Address
IMAS-Taroona
Nubeena Crescent, Taroona TAS 7053
Australia

Postal Address
IMAS-Taroona
Private Bag 49, Hobart TAS 7053
Telephone: +61 3 6227 7277

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